ONTARIO DEPARTMENT OF AGRICULTURE,
TORONTO. MARCH, 1900.

THE

SAN JOSÉ

AND

OTHER SCALE INSECTS

PREPARED FOR

THE USE OF FRUIT GROWERS AND SCALE INSPECTORS,

BY

WM. LOCHHEAD, B.A., M.S.,

PROFESSOR OF BIOLOGY IN THE ONTARIO AGRICULTURAL COLLEGE, GUELPH, ONT., CANADA.

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SAN JOSÉ AND OTHER SCALE INSECTS.

By Prof. Wm. Lochhead, Ontario Agricultural College.

The Scales discussed in this Pamphlet are:

1. The San José Scale.
2. The Ostreæform or Curtis Scale.
3. The Cherry or Forbes Scale.
4. The Putnam Scale.
5. The English Walnut Scale.
6. The Oyster-shell Bark-Louse.
7. The Scurfy Bark-Louse.
8. The New York Plum Scale.

INTRODUCTION.

The purpose of this pamphlet is to place before the fruit-growers, and all interested in the preservation of their orchards, the main facts regarding the life-history, habits, and appearance of the San José Scale, and of those Scales which are often mistaken for it. It is hoped that the descriptions and drawings of the various scales may enable the orchardist and inspector to identify any form which may be living on trees and shrubs, so that its presence may be reported to the authorities at Toronto, Guelph, or Ottawa. It is quite possible that the Scales are more widely spread through the Province than is generally believed, and only by the co-operation of the intelligent, observant fruit-growers is it possible for the Department of Agriculture to prevent their further spread, without a great expenditure of money for inspection. To many people, the presence of Scale insects in such alarming numbers within recent years is quite unaccountable, and the entomologists of Canada and the United States have been blamed by some for introducing the pests. It is true that very few scale insects were found in our orchards a generation ago, but it must be remembered that conditions as regards scale insects have altered very much during the last few years. The wonderful development of commerce, through the introduction of steam ships and railways, has brought us into close touch with many distant countries, whose

products we are willing to exchange for our own. With the exchange of products has come the exchange of pests which prey upon these products. Last century the Oyster-Shell Bark-Louse was introduced by settlers into New England, Australia and other countries, from Europe, so that it is now found all over the world. The San José Scale, whose original home is now supposed to be Japan, has, within recent years, spread from California over most of the United States, and portions of Canada. The Ostreæform or Curtis scale *(Aspidiotus Ostreæformis)*, which is quite prevalent in Europe, has been found in many districts in Canada and the United States during the past year, and it gives evidence of being troublesome to the orchardist. It is fair to assume, then, that the presence of so many scale insects in our Province is due, in a large measure, to the importation of foreign and tropical plants and fruits, and not to the carelessness of entomologists who may wish to increase their collection of insects.

In the United States and Canada there are about 125 species of scale insects known, and of these nearly thirty have come to us from foreign countries. Prof. Cockerell, of New Mexico Ag. Exper. Station, who is well acquainted with the scales of Mexico and the West Indies, tells us that there are 130 additional species in the tropics, any one of which may find its way to the United States or Canada.

What are Scale Insects?

Scale insects differ very much among themselves. Some, like the mealy-bugs, secrete a covering composed of a cottony material; some, like the lecaniums, secrete a waxy, hard, continuous layer, which forms a protection for the back; while others, like the San José and oyster-shell bark-louse, possess true scale-like coverings, composed partly of a waxy secretion and partly of moulted skins, beneath which the insect lives.

The San José scale produces living young, but most other scale insects lay eggs from which emerge six-legged larvæ, which are quite active for a short time, running about hither and thither in search of a suitable place to settle down and live by sucking the sap of the plant through their long slender thread-like mouth-parts. As the larva continues to grow it moults several times by casting off its old skin, and with each moult the female gradually loses its feelers, eyes, and legs, while wings are never developed. The male larva, after moulting twice or thrice transforms into an active two-winged in ect with long feelers, strong legs, and large eyes, but without mouth-parts. The adult life of the male is short. As soon as the male has fertilized the females it dies, so that every larval scale insect is fatherless and posthumous. Scale insects are, then, insects which reveal their true insect structure in their young larval and adult male states. The female has apparently become degraded, and possesses little else than the powers of feeding and reproduction.

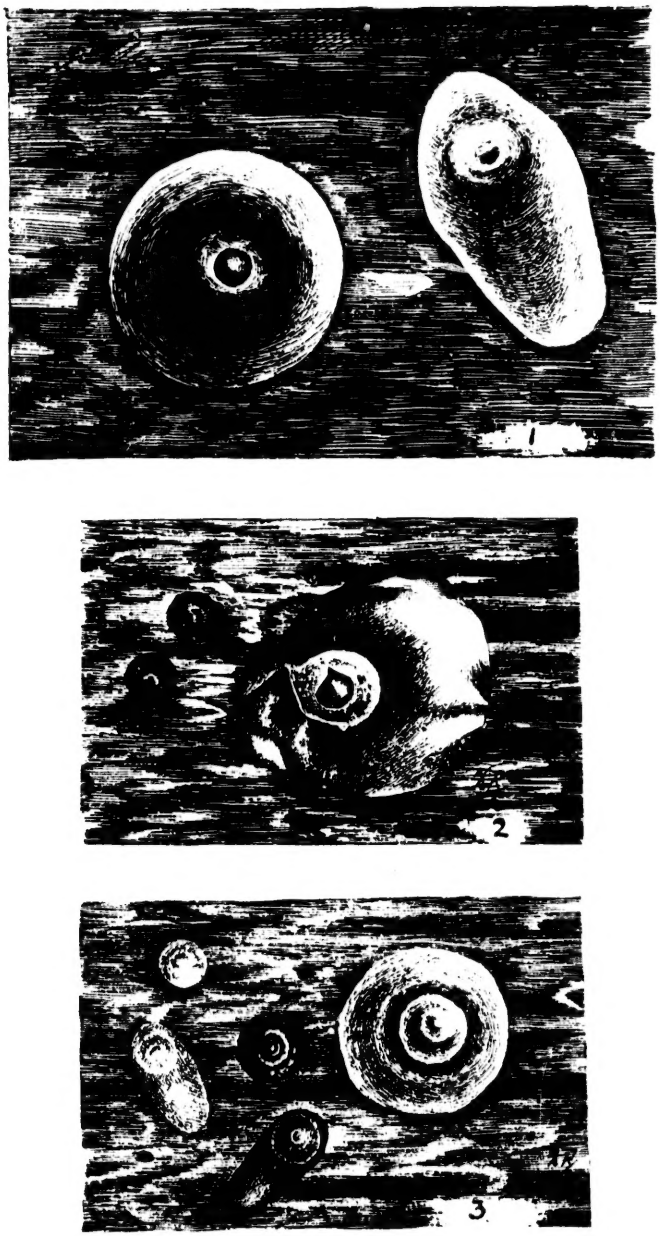


FIG. 1.—(1) Forbes Scale ; (2) Curtis Scale ; (3) San José Scale. (Original.)

1. San José Scale.*

(*Aspidiotus perniciosus.*)

Original Home.—Indirect evidence points to Japan as the probable original home of the San José Scale. Both American and Australian entomologists are convinced that the San José Scale was introduced into California and Australia on flowering cherry trees, plum trees, and other plants imported from Japan. In support of the belief, it may be said that such plants were found infested when they reached California.

Spread.—As early as 1873 the San José Valley orchards of California were badly infested, and in the previous year, 1872, its first appearance in Chili was reported. This pest, however, remained undescribed until 1880, when Prof. J. H. Comstock described it, and assigned to it the very suggestive specific name *perniciosus, i. e.*, pernicious.

From California the scale spread to Chili, New South Wales, and the Eastern States. Its appearance in the East was noted at Charlottesville, Virginia, by Dr. Howard, of Washington, in 1893. The infested plants, chiefly currant and pear, had been introduced three or four years before 1890) from a New Jersey nursery. Four years previous (1886) to this distribution of infested stock curculio-proof plum trees from the San José Valley had been planted in this same nursery, so that in all probability the San José Scale was introduced and distributed for several years before public attention was directed to the matter.

In connection with the introduction of the scale into New Jersey from California, it may be interesting to observe the exact circumstances, which are as follows:

Stark Bros., nurserymen, of Lewison, Missouri, had ordered curculio-proof plum trees from California, but when the two boxes of nursery stock arrived they appeared small and inferior in quality. Unwilling to accept the trees, Stark Bros. asked the California shippers for advice as to what should be done with them, and were instructed to forward them to New Jersey. These trees, no doubt, were the initial source of contagion.

From the fact that many other infested areas, which cannot be traced to New Jersey sources, became known soon after the Virginia discovery, it would appear that many direct importations from California and Japan took place. When Dr. Howard and Prof. Marlatt wrote their Bulletin No. 3, "The San José Scale: Its Occurrence in the United States," in 1896, the scale had gained entrance to "no less than fourteen States east of the Rocky Mountains, and is known to have occurred in as many as twelve nurseries, from several of which it has been sent out broadcast for upward of seven years." From New Jersey the scale was carried directly to Maryland, Indiana, New York, Ohio and Illinois, as well as to Ontario. The sources of the Ontario infestations are New Jersey, New York, and Maryland nurseries.

*Pronounced Săn-Hō-Sāy.

Fig. 2.

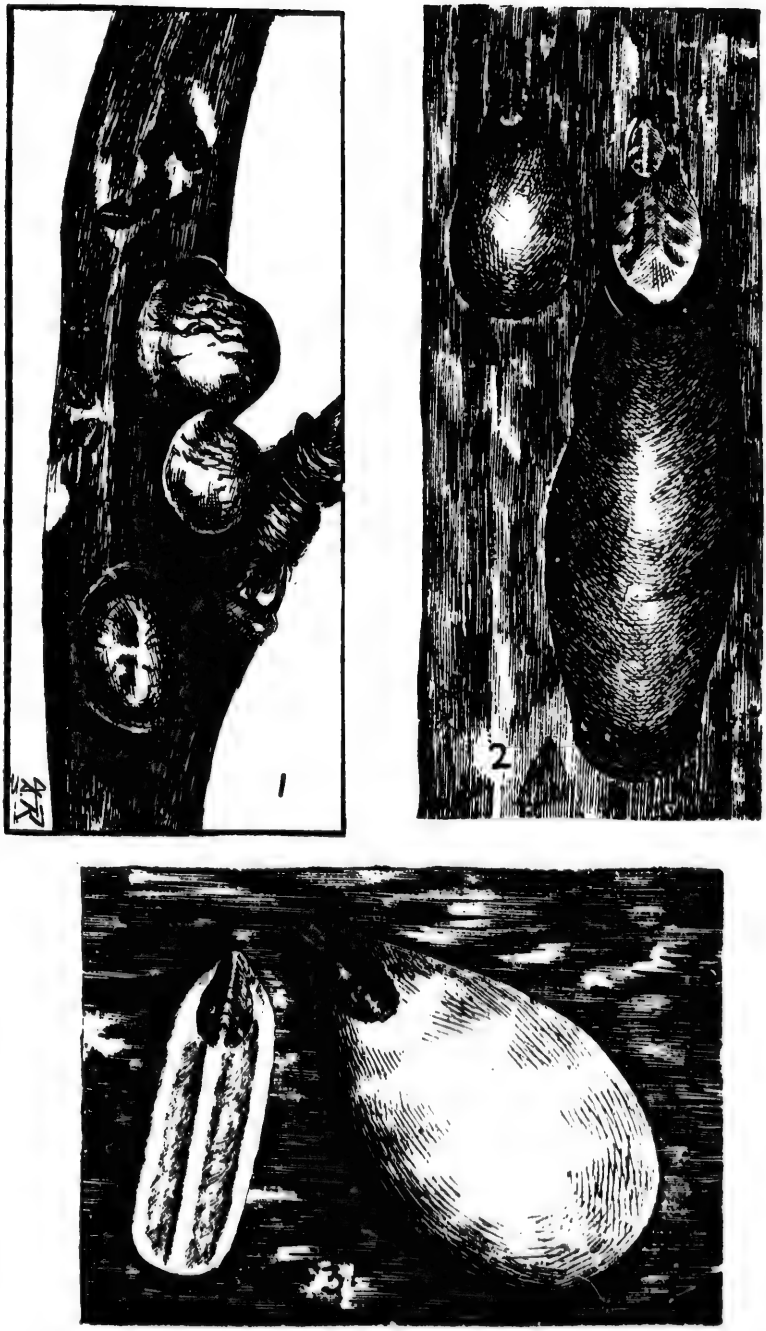


FIG. 2.—(1) New York Plum Scale; (2) Oyster-shell Bark-louse; (3) Scurfy Bark-louse. (Original)

The San José Scale has been reported from the following States and Territories of the Union: Alabama, Arizona, Arkansas, Colorado, California, Connecticut, Delaware, Florida, Georgia, Illinois, Idaho, Indiana, Kansas, Kentucky, Louisiana, Maryland, Massachusetts, Missouri, Michigan, Mississippi, New Mexico, New Jersey, New York, Nevada, North Carolina, Oregon, Oklahoma, Ohio, Pennsylvania, South Carolina, Texas, Vermont, Virginia, Washington, West Virginia, and District of Columbia.

The Scale in Ontario.—There is some difficulty in determining the exact length of time the scale has been in Ontario. The first reported occurrence was in Mr. John Vanhorn's orchard near Chatham. An importation of thirty Abundance and Simoni plum trees was received from the Parry nurseries, New Jersey, in 1895. Mr. Vanhorn disregarded the warnings contained in a circular sent out soon after by the Parry Bros., which intimated that in some manner San José Scale, from California had got into their nurseries. In the winter of 1896 many of these trees looked suspicious, and in January, 1897, specimens were sent to Dr. Fletcher, who identified the insect as San José Scale. In spite of vigorous treatment with the California mixture of lime, sulphur and salt, and whale-oil soap solution, the scale spread into an adjoining orchard, 30 rods distant. Mr. Vanhorn thinks, however, that if the whale-oil soap applications had been carefully and thoroughly made the scale would have been prevented from spreading, and the trees kept healthy and full of vitality.

On May 10th, of the same year (1897), Mr. Chas. Thonger, of Niagara, reported to Dr. Fletcher, that he had found scale on several of his dwarf pear trees. He removed several trees as being too badly infested to cure, and attempted to treat others not so badly infested with whale-oil soap. All of the early infested stock, he says, came from a Rochester nursery in 1894 and 1895, and as one of the trees showed unmistakable signs of disease in 1896, the indications are, as Mr. Thonger says, "that the scale may spread one or two seasons without being observed, or even longer, or migrate from the infested stock and develop more quickly in a new location." Although Mr. Thonger treated his trees with a weak whale-oil soap solution, the scale spread to other trees, and to neighboring orchards.

About eight years ago, several nurserymen and orchardists in the Niagara peninsula imported heavily from Little Silver, New Jersey; and it would almost seem as if the Little Silver nurserymen were aware of the infested state of their stock, for, as a rule, the stock was disposed of at lower rates than usual. In this manner the orchards of Messrs. Lee, Hutchison, Stuart and others, became infested. Again, prior to the placing of the embargo on American stock, many nurserymen bought heavily from Lovett and Berry, of New Jersey, so that infested stock became scattered throughout the Province. At the end of the shipping season, the imported stock left over after the orders had been filled was planted out in the nursery rows, and in this manner four nurseries became infested.

The outbreak in St, Catharines was observed in the spring of 1897. The scale spread very rapidly during the summer, and the danger became quite apparent. The trees which were infested had been planted in the spring of 1894; and in the fall of 1897, although the trees were loaded with fruit, many dead limbs were to be seen. The infested pear trees were purchased through an Ontario nurseryman from Little Silver, New Jersey. At the present time several orchards both in the city and in the immediate vicinity are infested.

The next occurrence reported was in Mr. John D. Wigle's orchard at Kingsville, on Nov. 11th, 1897, when a few pear trees showed a lack of vitality. The scale in this case was first observed on the fruit. The orchard was planted in 1888; but replanting took place in 1891, to fill in vacancies. These replants were obtained from a Canadian nursery; and it is supposed that they became centres of infestation, as the outbreak occurred at four points where replanting had taken place. The San José Scale is now found in five different orchards at Kingsville.

Guilds, in Kent County, is another area of infestation. The first occurrence was in the orchard of T. P. Warner, who noticed in 1897 that his trees were dying. The original source of this infestation was some nursery stock imported from Maryland in 1891 or 1892. Here, too, the scale has spread and is to be found in several orchards.

Another outbreak was reported from Belleville, in the summer of 1899. All the infested trees in this locality have been traced to a nursery from which infested stock was sent to various parts of the Province, and sold at a low price on the market. I am informed, however, that all these infected trees have been removed willingly by the owners.

The infestation at Burlington, near Hamilton, was unwittingly introduced about six years ago, on stock procured through one of our own nurserymen. Four or five infestations have been located and about one hundred trees destroyed.

At St. Thomas the scale was introduced probably five years ago into Mr. G. Upper's orchard. Six years ago Mr. Upper planted out an orchard of 300 plums and pears, of which some died and were replaced. One of these replants which made no growth, and finally died, is supposed to have infested the remainder of the orchard.

The two infested trees found at Guelph were imported directly from New Jersey, by Mr. Alexander, the owner. They have been destroyed.

Other isolated infestations occur at Beamsville, Grimsby, Winona, Stony Creek, Bartonville, and Dundas, the sources of which were the large importations made about eight years ago by several nurserymen of this district from Little Silver, New Jersey.

The San José Scale has been found in seven nurseries in Ontario; and for a short time infested stock was sent to various parts of the Province, but the Department of Agriculture dealt very vigorously with the infestations in the nurseries, traced up the infested stock, and had it destroyed. It is hoped that the Fumigation Act, which compels all

nurserymen to fumigate their stock with hydrocyanic acid gas, before its distribution from the nurseries, will prevent a recurrence of the conditions spoken of. If the nurseries are kept free from scale, no wide distribution of the pest can take place; and at the present time it is the duty of every nurseryman to conform to the requirements of the Act, even at a considerable sacrifice.

The foregoing statements should convince even the most skeptical that the assertion made by some orchardists that the scale has been in existence in Ontario for over twenty years is not warranted by facts. Twenty years ago the San José Scale was not known outside of California, and there is no indication of its occurrence east of the Rockies before 1886, when curculio-proof plum trees were introduced into New Jersey nurseries.

If scale was found twenty years ago in Ontario, it was probably the Putnam Scale, which resembles the San José Scale very closely; for the Putnam Scale is a native species and is widely distributed, but seldom becomes a dangerous pest.

Instances of Death of Trees from the Attacks of the San José Scale.—Most persons must have convincing proof of the destructiveness of a pest before they will voluntarily make strong efforts to combat it. During the early stages of the fight against the scale in Ontario but few cases of death occurred among our fruit-trees, the result being that the orchardists did not believe the scale to be destructive, as it had been pictured. Moreover, the worst infested orchards were cut down and burned before the public saw the full effects of the visitation of the pest. No "awful object-lessons," in the form of hundreds of acres of dead orchard trees, such as could be seen in Maryland, were presented to the people of Ontario.

As time passed on, however, many decided instances were observed, and, as a rule, the owners of these dead trees reported to the San José Scale Commissioners that they were favorably inclined to the axe and fire method of dealing with the infested trees.

A few instances where dead trees have been seen and reported are here given for the purpose of convincing some who seem to persist in the mistaken belief that the scale is comparatively harmless:

1. Several dwarf pear-trees and currant bushes dead from the effects of the scale in Mr. A. W. Wright's orchard, Niagara.

"In the case of pear-trees which had been planted in the place of trees which had been badly infested the previous year, very good growth had been made (2 feet of new wood), but this new wood was shrivelled and turning black. These trees were almost destroyed in one season."

2. Several dead trees in the orchard of Mr. Jas. Hutchinson, Niagara.

3. In the orchard of Mr. A. Sandell, Niagara, the trees looked healthy, leafed out, and remained green till September, when they

showed signs of weakening. As winter came on, some trees died outright, while others were badly injured.

4. In Mr. Aaron Cole's orchard, St. Catharines, several five-year-old plum trees were killed. These had been infested but three or four years.

5. A reliable observer saw dead trees in the orchard of Mr. Kottmeyer, St. Catharines.

6. Mr. John Stuart, St. Catharines, stated that, out of an orchard of five acres, more trees died out of a corner of 50 or 60 trees (infested) in the first three years, than in all the rest of the orchard.

7. Mr. Trueman Warner, of Guilds, stated that he had large full-grown apple trees from 20 to 25 years of age killed.

8. In Mr. John McDougall's orchard, near Guilds, 40 trees died from the effects of the scale.

The Life History of the San José Scale.—The larvæ of the San José Scale insects are born alive, (Fig. 3). The eggs hatch within the body of the mother, from which the young, lemon-colored larvæ escape soon after, to search for suitable places on the branches and twigs upon which to settle. The larvæ are very minute at first, visible under a magnifying glass as yellowish specks, probably about 1-100 inch in length (Fig. 5). Each larva has two feelers, a long thread-like beak through which the juices of the plant are sucked up, and six stout legs, by means of which it can move about quite rapidly. Observations were made this season on the speed with which it travels. I found numerous instances where a larva travelled three inches in 10 minutes; but, as this distance was not in a straight line, its apparent speed was much less. In most cases, the course was of such a wandering nature that after three or four hours it was only an inch or two from its starting point. When the young larva has found a suitable place to settle, it inserts its thread-like beak through the bark into the juicy tissues beneath. A waxy secretion from the outer parts of the body soon forms a covering, and instead of seeing the lemon-yellow body we now see the grayish or grayish-yellow scale covering. Even at this young stage the central nipple is generally quite prominent, though sometimes it appears to be wanting altogether. As the insect (Fig. 6) becomes more mature, the scale becomes darker. About the twelfth day after the birth of the larva, the first moulting takes place, and with the casting of its skin, the female loses its eyes, feelers, and legs, while the male loses only its feelers and legs. The female becomes circular and flat, and is slightly smaller than the male. About a week after the first moult, the male moults a second time, at which time the larva (or pro-pupa) has dark purple eyes, and the feelers and legs have re-appeared. The female moults for the second time about two days later, that is, about eight days after the first moult. It has now become even more circular than it was before, and the last segment is very much like that of the adult female.

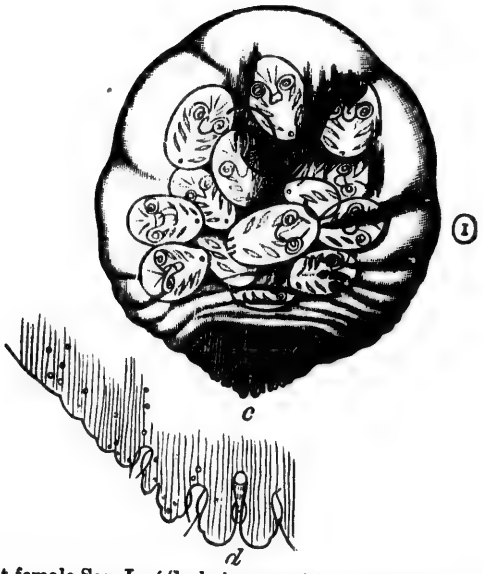


FIG. 3.—Adult female San José Scale insect, with covering removed, showing eggs and young within the body (Div. Ent. U.S. Dep. Agri.).

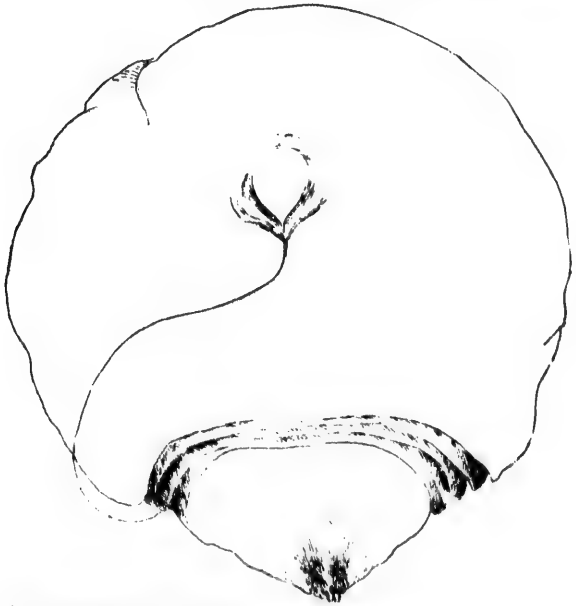


FIG. 4.— Adult female San José Scale insect before impregnation, scale covering removed ; greatly magnified. (Original.)

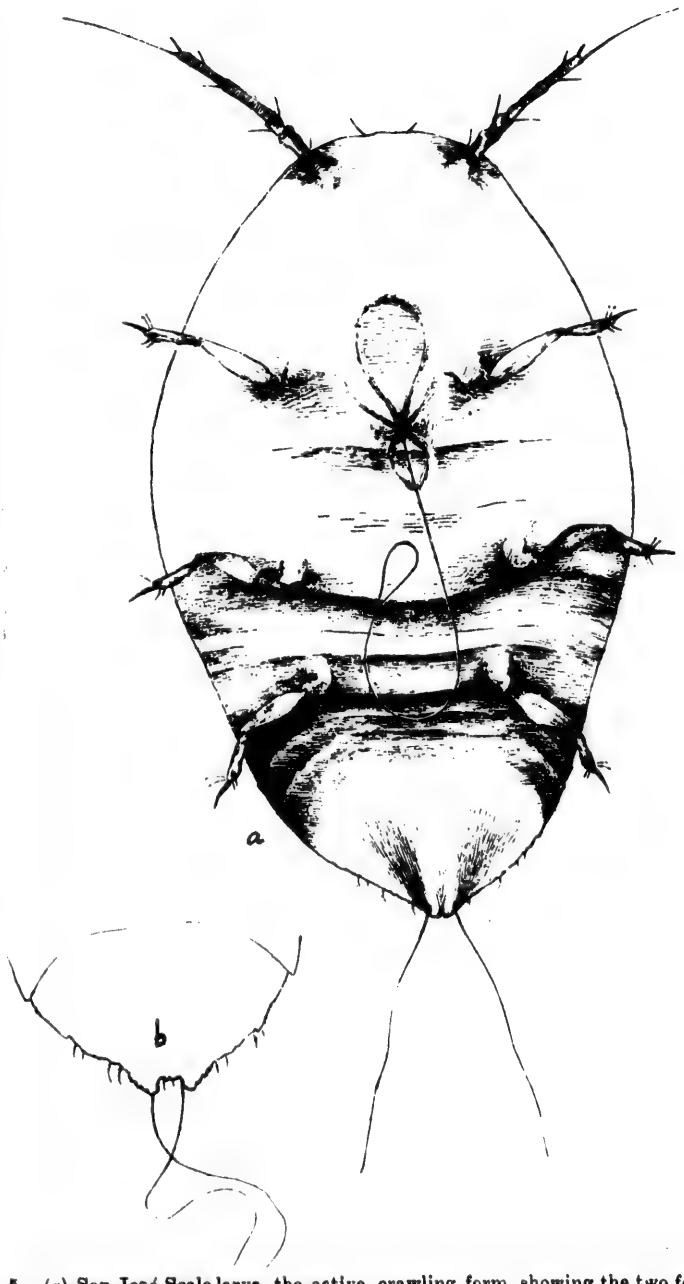


FIG. 5.—(*a*) San José Scale larva, the active, crawling form, showing the two feelers, six legs, and long sucking tube; (*b*) enlarged drawing of anal plate. (Original.)

The male transforms into a true pupa about two days afte. its secon moult. The eyes are still dark purple, and there is now an anal styl instead of two. About five or six days later, or about twenty-five o twenty-six days from its birth, the adult male emerges. It backs out from the rear end of the scale, a movement which I have often observed. The adult male (Fig. 7) is a two-winged insect with prominent feelers or antennæ and anal style. The eyes are dark purple, as in the larva and pupal stages.

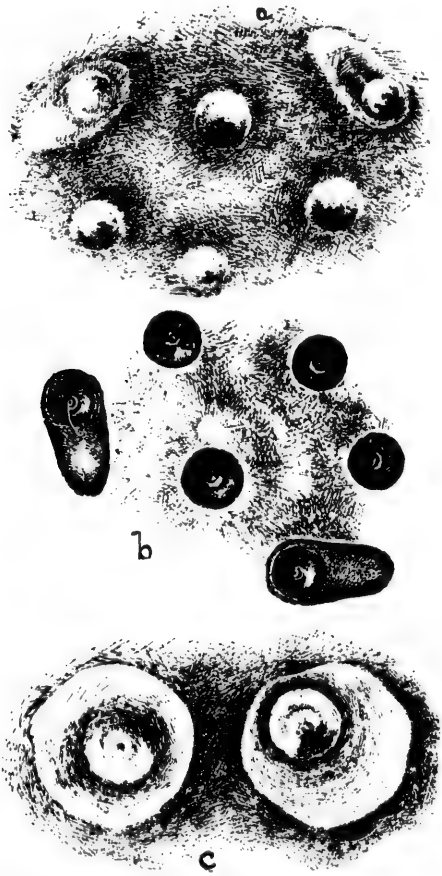


FIG. 6.—San José Scale (*Aspidiotus perniciosus.*)
(*a*) Four young scales and two male scales, showing the nipple and ring even in very young forms.
(*b*) Four immature female scales, and two nearly grown male scales, showing the prominent nipple and circular groove about the nipple, of the black scales.
(*c*) Two small female gray scales, showing the central nipple and circular groove. One scale has a nipple not central. The body of insect is beneath the scale. (Original.)

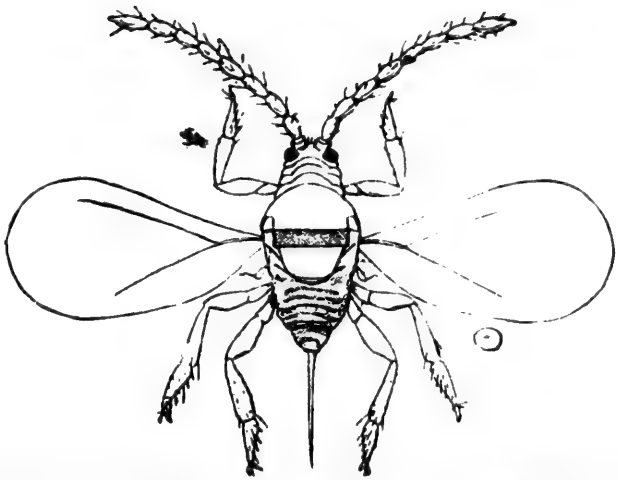
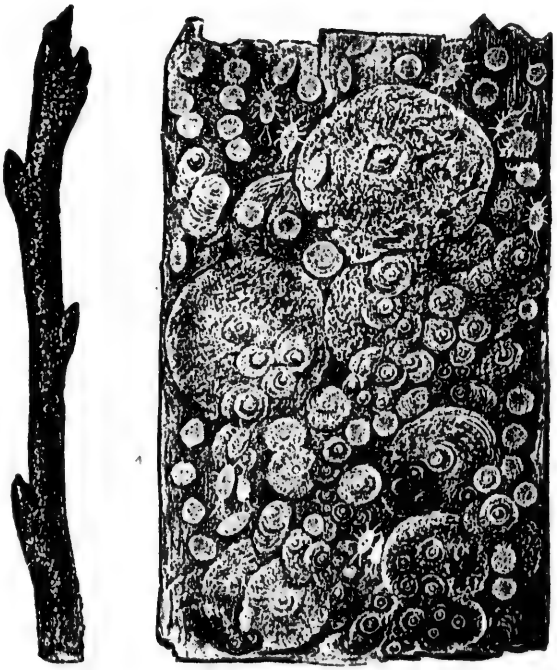


FIG. 7.—Adult male insect of San José Scale, escaped from covering scale, showing the two wings, two feelers, two eyes, six legs, and long anal style. (Div. Ent. U.S. Dep. Ag.)



a *b*

FIG. 8.—A portion of branch covered with San José Scale. Appearance of scale on bark; (*a*) infested twig, natural size; (*b*) bark as it appears under hand lens, showing scales in various stages of development and young larvæ.

The adult female (Fig. 4) destitute of eyes, feelers, legs, and wings appears about 30 or 31 days after birth, and in another week the young larvæ make their appearance from beneath the scale. The embryonic larvæ can be readily seen within the body of the mother, surrounded by a thin membrane, which breaks before the larva leaves the body. (Fig. 3)

The young larvæ are to be observed any time between June 15th and Dec. 1st, when severe frosts compel them to take shelter beneath the scale, where they remain dormant until spring. All stages of maturity of larva can be obtained in the winter condition.

The mature females are very prolific. From reliable observations made in Washington it was found that the average producing period of a mature female was six weeks, and the number of young produced was about 400, an average of ten for every twenty-four hours. But as a newly born larva will become mature and capable of producing young in about 38 days, there will be a continuous intermingling of generations from June to December. According to Dr. Howard's observations and calculations a single mature female will, under most favorable conditions, which are never obtained, have a grand total of over three thousand millions in a single season!

Description of Male Scale.—The adult male scale is oblong in outline, with the nipple near one end, and is much smaller than the adult female scale. The color is usually of a dark grey, with the circular raised portions containing the nipple and first moult slightly darker. The central portion of the nipple is generally dark or grey, but sometimes light yellow or lemon-colored (Figs. 1 and 6).

Description of Female Scale.—The color varies with the age of the insect. The very young scales, *i.e.*, those which have settled but a few days, are round and nearly white, often with a decided central nipple. After the first moult the scales become almost black, with a conspicuous depressed ring around the nipple. Near maturity the scales are grey, the central portions of the nipple being yellow (Figs. 1 and 6).

The nipple is central, unless roughness of the bark prevents a regular development of the scale, when the scale may be oblong, and the nipple not central, or eccentric.

Microscopical characters.—(Fig. 9) Median lobes of anal segment well developed, erect, and notched on outer margin; second lobe half the length of the median, notched on outer margin, and pointed; third lobe small or absent; incisions between median and second lobe, *well marked, narrow* and *deep*; the chitinous thickenings between the median and second lobe are *nearly equal in size*, the inner being slightly the larger, and *close together;* a small chitinous thickening on either margin of median lobe, those of second incision small but distinct; plates small and spine-like, usually serrate, sometimes branched; a pair of plates on third lobe and several beyond; *ventral glands absent.*

Notes on the General Habits of the San José Scale.—The arrangement or grouping of the San José Scales on the bark is often quite char-

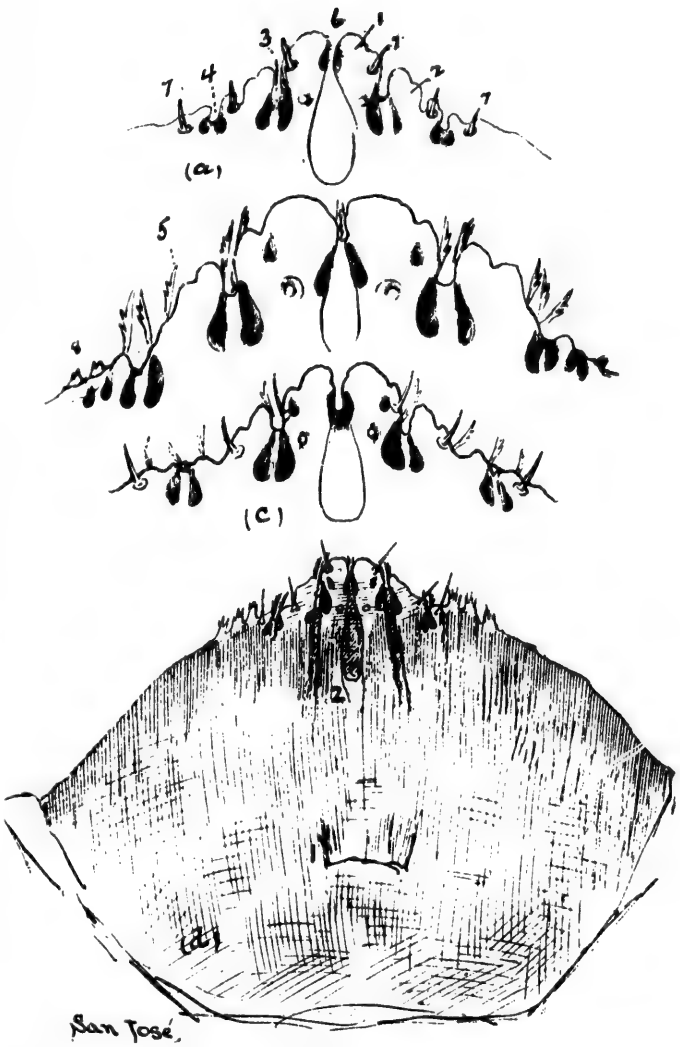


FIG. 9—Anal plates of female San José Scale.

(*a*) Anal plate showing median lobes (1), second lobes (2); incisions (6), (3), (4); chitinous thickenings on each margin of these incisions, and the spines (7) on each of the lobes. (The plates have not been drawn in this case.)

(*b*) Anal plate showing the lobes, incisions, thickenings, and plates (5); a pair of plates between median lobes, a pair at first incision, and three at second incision. Notice the large size of second lobe, which is notched once on the margin. (Spines have not been drawn.)

(*c*) Anal plate showing both spines and plates. Notice the chitinous thickenings between the median and second lobes are nearly equal in size and close together.

(*d*) Anal plate and last segment of adult female. There are no ventral glands. (1) Vaginal opening, (2) anal opening.

acteristic, and is frequently sufficient to fix their identity. In slight infestations these scales seldom have a tendency to cluster, but, instead are scattered somewhat evenly on the bark. (Fig. 8).

In badly infested orchards the presence of the scale on new growth and the fruit produces a deep purplish-red coloration in the tissues just beneath the epidermis.

During late summer (July and August) there is a very marked increase in the number of male scales, while in fall the proportion of male scales is much decreased.

The absence of eggs or empty shells in some cases gives a clue to the kind of scale, since the Forbes and Putnam Scale insects deposit eggs.

The San José Scale leaves no conspicuous, ventral, whitish scale on the bark after the removal of the insect, as does the Scurfy Bark-Louse.

When trees or shrubs become badly infested it is not an uncommon thing for the bark to be covered so thickly that it is entirely obscured. Sometimes the scales overlap one another so closely that they are three or four layers in thickness. Occasionally, however, this layering occurs only at the bases of twigs and branches, in which cases the remedy to be applied should be one which will soak through the different layers. Crude petroleum has this property of penetration, and herein lies its efficacy as a scale insecticide.

When the bark becomes thickly covered it has a gray, ashy appearance, due to the presence of large numbers of mature scales. When the tree is alive and the scales abundant, one can prove if the insects are alive by crushing them with a knife or thumb-nail. If a yellow, oily substance exudes, they are alive, but if the scales are dead no oil will make its appearance.

How the San José Scale Spreads.—During the summer large numbers of minute, yellowish lice will be found crawling over the branches, twigs, leaves, and even the fruit. It is during this active period of the scale insect that the pest is readily distributed, for the minute bodies are easily removed and carried to other trees. (Fig. 8).

Birds alighting on infested branches, where the young lice are crawling about, will likely carry away a few on their feet to other trees. It has been noticed that infestations are generally more pronounced about birds' nests, although some contradictory evidence in this respect has been received. In order to ascertain to what extent birds are responsible for the spread of the scale, Mr. G. E. Fisher, Head Inspector, conducted an examination of a number of birds' nests found on trees. Out of 22 nests examined scale was found on only two, both of which were in infested orchards. In another case, however, Mr. Fisher says the scale was unquestionably carried by birds. In Mr. Green's orchard, at Niagara, one tree containing a bird's nest, distant 150 yards from an infested orchard, and in the opposite direction from the prevailing wind, was found so badly infested that it was nearly dead.

A strong *wind* will also carry away larvæ to other trees in the im

mediate vicinity, but to what distance has never been definitely ascertained. The observations of the past few years, however, prove pretty convincingly that the scale spreads chiefly in the direction of the prevailing winds.

Man himself may be an agent in the distribution of the scale while he is cultivating the land beneath the trees or picking the fruit. There are evidences that go to show that the scale has been transferred from one tree to another, and from one orchard to another by the fruit-pickers. A good instance of distribution of scale by fruit-pickers was observed in Catawba Island, Ohio. A tree at a road-corner, beside which the fruit-pickers piled their empty baskets at night, distant from any other infested tree, was found to be badly infested, undoubtedly by the scale carried on the baskets.

Another possible method of distribution is by means of *infested fruit* which is offered for sale in markets. Authorities are not agreed in this matter, some asserting that the opportunities for the distribution of scale in this way are very few. In the case of summer or fall fruit, which is sold for immediate use, it is quite possible that larval scales may be crawling about and be carried to trees by sparrows and other birds which feed on peelings, etc., but in the case of winter fruit, on which immature scales are fastened, the probability of these becoming mature in the following June is very slight indeed.

However, steps should be taken to prevent infested fruit from leaving the country, lest a prejudice arise in the minds of the importers against the entire fruit crop from the fact that it comes from an infested country.

Some of our inspectors have a theory that the adult male insect, which is winged and strong, carries larvæ from one tree to another. Mr. J. F. Smith, of Glandford, the very careful and observant inspector for the Guilds district, noticed that there were more Greening trees infested than any other variety. He thinks that if the larvæ had been brought to these trees by accidental circumstances, such as wind or birds, then the other varieties would have stood as good a chance of being infected as the Greenings.

But if the gentlemen who have brought forward this theory would answer the following questions they would find that their hypothesis is a very unsatisfactory one from a scientific standpoint: 1. What is the function of the male scale? 2. What object would the male scale have in flying to an uninfected tree? 3. Would the male scale likely carry larvæ other than its own, on the hypothesis of the struggle for existence? 4. Does a male scale ever see its own progeny?

Evidently some more plausible theory than this one must be produced to account for the infection of certain trees in preference to others.

The San José Scale and Climatic Conditions.—It has been observed for some time that other conditions than mere food supply determine the presence or abundance of scale insects in any particular region. There

are districts in the United States and Canada where the scale has not y made its appearance, yet food plants are there in sufficient abundanc Some observers, however, are of the belief that the San José Scale wi thrive wherever its food plants can flourish. They base their belief o the fact that it has survived the almost arctic severity of 22 degrees belo zero for several days during the winter of 1898-9 in Ontario, and a sti lower temperature at St. Paul, Minn.

It is possible, even probable, that differences in the amount of humi ity in different regions are of greater importance than extreme tempera tures in determining the prevalence of this scale. Messrs. Marlatt an Pergande, of Washington, are of the opinion that short and cool summer with relatively high humidity are the determining factors in Europ which keep the scales under control. These same observers state tha practical immunity obtains in regions characterized by great heat an dryness in summer. They instance the case of that part of Californi away from the coast, which has dry summers, like those of Italy an Spain, and which is practically free from scale insects.

So far as Ontario is concerned the scale has been discovered in a flour ishing condition far into, what Dr. Merriam calls, the "transition zone, where Dr. Howard thought it would not occur in injurious numbers I refer to the outbreaks at Belleville, where several trees were foun badly infested, although thoroughly exposed to the cold winter winds and at Guelph where the scales on one tree had survived two winters

From the fact that the scale hibernates in California for a few months, and appears to thrive best in moist months, Prof. J. B. Smith suggests that the native home of the scale may be in the Northern Pacific States. "It is likely that the best environment for it is a temperate somewhat moist climate, and that intense dry heat is not in the long run favorable for its rapid reproduction. This seems to be proved by the almost universal testimony that May and June in California are the months during which the larval scales are most abundant, that during midsummer there is little hatching, and that at this period scales seem frequently to be killed by the intense heat. Furthermore, it is claimed that in some localities into which the scale has been introduced it has been promptly killed off completely by the intense summer heats. It is interesting to note that the scale was least troublesome in the most southern parts of California, that it was most destructive from San José northward, and that its disappearance from natural causes was confined to points from San José southward." (1896 Report, N.J.)

Methods of Treatment for the San José Scale.—Acting under the advice of Entomologists who have had much experience in dealing with San José Scale, and in the belief that the scale was in but a few orchards, the authorities in Ontario undertook to uproot all badly infested trees, as well as those but slightly infested, and to destroy these by fire. This method of total destruction is very effective if all infested trees can be located, and it is still recommended for trees of little value even by those

who advocate the adoption of remedial treatment. However, as the areas of infestation increased in size, and as many valuable trees became involved, remedial treatment became very urgent.

Four methods have been tried in the United States with varying degrees of success.

a. Fumigation by hydrocyanic acid gas, generated under tents placed over the trees.

b. Whale-oil soap solution applied hot by spray-pump, or cold by a brush.

c Crude petroleum, pure or dilute, applied by spray-pump.

d. Kerosene solution applied by spray-pump.

Experiments with whale-oil soap, crude petroleum, and 20% kerosene have been tried recently in several infested orchards at Niagara, St. Catharines, Winona, Burlington, Chatham, Blenheim, Guilds, Kingsville, St. Thomas and Port Burwell. The results of these experiments will not be known till July.

a. Hydrocyanic Acid Gas.—This method of treatment has been tried with gratifying success in California on citrus trees, and in Maryland on young pear, apple, and nectarine (Bull. 57, Maryland, Prof. W. G. Johnson).

The operation is similar to that adopted by nurserymen in the fumigation of nursery stock, except that the gas is liberated under a tent placed over the tree. The cubic contents of the tented tree are computed, and for every 125 cubic feet of space, 1 oz. of potassium cyanide, 1½ fluid ozs. of sulphuric acid, and 2¼ fluid ozs. of water are used. The acid and water are first put into a glazed crock, or other suitable jar, and the potassium cyanide is dropped in very quickly. Then the tent is immediately closed and made air-tight. The tent remains closed for 45 minutes, when it is removed and placed over another tree. Eight-ounce cotton duck, thoroughly oiled with linseed oil, is generally used in the construction of the tent.

The *objections* to the adoption of tent fumigation in our Ontario orchards are: (1) the large size of most of our fruit trees, (2) the difficulty of handling the tents, requiring the services of experts, (3) the cost of the tents, especially large ones, probably about $20 each, (4) the cost of the chemicals necessary for large tents, (5) the time required to fumigate an orchard, (6) the danger of poisoning from a careless use of the gas, and (7) the difficulty in keeping the tents free from holes.

The merits of this kind of treatment are: (1) the sure death of 99 per cent. of the scales on the tree, (2) the killing of aphids or plant lice and other insects which lie concealed in curled leaves or crevices, which ordinary sprays will not reach, and (3) its feasibility for small trees and shrubs which would require small tents.

b. Whale-oil Soap Solution.—This mode of treatment is one which has been employed for a long time against scale insects. The best soap

is now made from Menhadden fish oil and caustic potash, and has been found very effective wherever the work has been done thoroughly.

Since 1894 many experiments have been conducted by prominent entomologists of the United States towards the destruction of the San José Scale: all of which proved that the scale is held in check *very perceptibly but not eradicated.*

The best proportion of soap and water to be employed is two pounds of soap dissolved in one gallon of hot water. The soap, thus diluted, can be applied during winter and early spring without fear of injury to our fruit trees, with the exception of the peach, whose fruit-buds are apt to be destroyed unless the application is made when the buds are beginning to open, or when the reddish tinge comes to the opening buds.

Prof. Webster, of Wooster, Ohio, in a recent bulletin says: "With regard to the effect of these applications of the whale-oil soap on the San José Scale, while it has not been exterminated, it has been greatly reduced, so much so, in fact, that the owners of infested orchards have now little fear but that they will be able to eradicate it entirely within the next two or three years. For my own part, I have never felt so encouraged over the prospect of overcoming the San José Scale in this locality (Catawba Island) as at the present time. Growers claim that the treatment with whale-oil soap for San José Scale has given them an average of $1 per tree profit, the soap costing them about 4c. per pound laid down."

"For the grower who wishes to use an absolutely safe material that will kill at least 95% of the scales infesting his trees, nothing is better than whale or fish-oil soap, applied two pounds to one gallon of water after the first of January, but applied prior to that time there is danger of killing fruit buds." (Prof. J. B. Smith).

In the preparation of the soap solution the water is first heated in kettles or boilers, then transferred to a barrel, capable of holding (say) 50 gallons. One hundred pounds of the whale-oil soap are then added, and thoroughly dissolved in hot water. The solution is applied while hot by means of a spray-pump.

In Ohio the peach leaf-curl has practically disappeared from orchards treated with whale-oil soap solution.

As a summer treatment peach orchardists use a much weaker solution (¼ lb to a gallon of water), once a week or oftener, to kill young lice which may be moving about.

Thorough spraying is necessary, and to do this 1½ gallons of soap solution are required for an ordinary-sized peach tree.

c. Crude petroleum. This is a comparatively new insecticide. Prof. J. B. Smith, State Entomologist of New Jersey, experimented somewhat extensively with this substance on four thousand peach, pear, apple, and plum trees, which varied in age and size from nursery stock to old trees in full bearing.

He found that not a single case of injury resulted from treatment to trees in the winter; that the crop of apples and pears the year following was not diminished when the applications were made after January 15th; and that the fruit buds of plum and peach trees were not injured by applications in March.

Prof. Smith made no early winter experiments on bearing orchards, consequently he cannot give results for treatment made during this time. He summarizes the results of his experiments in these words: "Crude petroleum oil will kill the San José Scale in winter whenever it comes into sufficient contact with the insect. It is fully as effective against scale insects as kerosene, and as harmless to the most tender varieties, and on the youngest trees. (Bull. 138, N.J. Agric. Experiment Station, Sept. 5, 1899.)

Again, Prof. J. B. Smith, in a letter dated Nov. 14th, states:

"The advantages of the oil over the soap are: It goes about one-half further; it requires no preparation before spraying; it is much more penetrating, reaching points that the soap does not reach, and it is much more effective where scales are massed in considerable numbers, because it will penetrate through any number of layers as easily as it does through one. I tried soap and crude petroleum on two peach trees side by side last winter. I looked at the two trees carefully only a day or two ago. I found some scales all over the old wood of the soap treated tree, so that I would not dare to let it go another season without any treatment. The oil-treated tree is practically clean. There are some scales on it, but so few that there would be no danger whatever in letting the trees go for another entire year without any attention whatever. I claim that the oil will not hurt trees, and that it will kill every scale that it touches."

The same authority recommends the use of an emulsion of crude petroleum rather than the undiluted form, and that an emulsion sprayer, arranged with two or three nozzles of the Vermorel type, should be used.

He adds: "A gallon of emulsion containing 25 per cent oil, will give a better coating than a quart of oil undiluted, and the material can be applied until everything is dripping."

As a summer treatment crude petroleum will not do, from the fact that it chokes up the breathing pores of the leaves, and if used in the winter it must be heated up to 70 or 75 degrees before it will flow freely from the nozzles or mingle with the water in the proper proportions.

d. Diluted Kerosene. Kerosene diluted with four parts of water, has been used with good results in New York State for three years, and is more easily applied than whale-oil soap.

It is also claimed that the kerosene mixture "may be applied to the leaves or buds at any time without injury." (Bulletin 144, Cornell Agric. Experiment Station, January, 1898); and that "A 20 per cent. mixture of kerosene can probably be safely used on the peach at any time, but a stronger mixture cannot always be so applied." (Bulletin 155, Cornell Univ. Agric. Experiment Station, December, 1898.)

"While spraying for the San José Scale in early spring during weather favorable to early evaporation has given excellent results, there is no reason why late fall spraying should not be equally effective, since the insect continues to multiply for some time after the leaves have fallen. Furthermore it is often more convenient to spray in the fall than during the hurry of spring work. Summer spraying is rarely advisable, since the foliage prevents the insecticide from reaching all parts of the tree." (Gould, Cornell Bull. 177, Jan. 1 00.)

Prof. Webster, however, states that "diluted kerosene can be used for summer treatment, for destroying the young, but we have not seen any indications that it would be at all effective as against full-grown scale during the winter season". (Bulletin 103, Ohio Experiment Station, March, 1899).

Many persons have pointed to California as an instance where the San José Scale is not feared so much now as it was formerly on account of the efficiency of winter washes, and predaceous and parasitic insects, but they should remember that California is rather an exceptional region.

The resin and the sulphur washes so effective there are valueless in the eastern portion of the continent, owing to differences in climate. In the east, the rain, snow, and other agencies do not allow the California washes to operate sufficiently long before they are washed off; while in California, the long dry season, at the beginning of which the washes are applied, allows the operation to be prolonged, and hence quite fatal to the scale. Moreover, the predaceous insects are more effective in southern California than in the east, for the reason that many of them can breed almost the year round in the mild winters of the Pacific coast.

The Opinions of Some Prominent Entomologists Who have had Experience in Fighting the Scale.

Prof. Webster, in Bulletin 103, Ohio Agric. Experiment Station, March, 1899, writes as follows regarding the burning of infested trees:

"While this measure is sometimes the most expensive, it is the only one that is absolutely effectual under all conditions. Besides, it is not infrequently the cheapest in the long run. When we come to count the cost in time and material of saving a tree that is past its prime, or is of a variety that is not of the best, or when a very young tree, only recently set, is found to be badly infested, it will be cheaper to clear everything up and burn, thus at once settling the whole problem. I think it will pay to try and save trees not seriously affected, if such are of desirable varieties and have nearly reached the bearing age, or have not yet reached their best, but the treatment must never be left to the private individual. It must be the business of some person who has official authority to see that the work of treating is done properly and at the proper time, else it will, as a rule, amount to nothing. While I believe this pest can be controlled by the application of repressive insecticides, experience has shown that in nine cases out of ten this will not be done."

(For Prof. Webster's views on the use of whale-oil soap see page 24.)

Prof. Forbes, of Illinois (Bulletin 56, July, 1899), says:

"Trees so covered with the scale that the surface of the bark was generally concealed were commonly cut out and burned. The San José Scale can clearly be kept in check by thorough spraying with whale-oil soap, but it can be exterminated where it has once effected a lodgment only by drastic measures of destruction supplemented by spraying, or by repeated treatment applied in every case just as soon and just as frequently as a watchful inspection gives any evidence of the presence of the scale."

In a letter received from Prof. Woodworth, State Entomologist of California, dated December 4th, 1899, he says:

"While it is true that the California orchardists have no particular fear of this scale, it is not because they consider it an unimportant matter, but simply because they have learned by experience that they can control it. The San José Scale remains the most injurious scale insect, perhaps the most injurious fruit insect, in this region if not controlled. Had I an orchard here or in the east I would certainly take every precaution to prevent the introduction of the scale, very carefully inspecting all stock planted and destroying by fire any young trees found infested. If, however, the scale became established in spite of these efforts I would by no means despair, nor practice wholesale destruction of the trees, but would begin to fight the insect along the lines laid down in an article published in the *Fruit Growers' Journal* of October, 1898."

Prof. Starnes, of Georgia (Bulletin 36, October, 1897), says:

"Far and away the best prescription is the mattock and matchbox. Where the infestation is slight and extends to but a few trees, the monetary loss is of little moment and absolute extinction of the scale is the result. Where the trees are badly infested their loss is inevitable anyway, even should remedial treatment succeed in ridding them of the pest, for their vitality will be found to have been sapped to such an extent that they will never prove commercially profitable, and both time, money, and future trouble will be saved by adopting heroic treatment. Moreover, it is almost an impossibility to absolutely extinguish the scale when once fully entrenched. It may be apparently all killed, but a sufficient number will be found to have survived, under rough edges of bark, and in crotches, crevices, and other protected places, to speedily reinfest the tree if the treatment is intermitted or discontinued."

Prof. M. V. Slingerland, Cornell University, says:

"We have not reached the end of our experiments in trying to control the scale, so that no one can affirm that there is absolutely no hope for a tree infested, and that, therefore, it should be destroyed root and branch. On the other hand, we do know that intelligent persons have, not only in our own state, but in others, successfully checked, and are now controlling this serious pest just as easily, and, in many cases, more satisfactorily than they are some of the other orchard pests, like

the codling moth. Where young trees, and in some cases even old trees, are very badly infested, the cheapest way, I believe, is to burn the trees at once; but in a case with which I am familiar, in the Hudson River Valley, an intelligent orchardist has a large orchard from which he clears from $4,000 to $6,000 annually, and in the centre of this are between two and three hundred trees more or less infested with the San José Scale. He is fighting the pest intelligently and reducing its number."

Prof. W. G. Johnson, of Maryland, says:

"My experience has been such with this insect that I believe that only by the most energetic and persistent warfare will we be able to keep up our horticultural interests. The damage in this state is very great, as you know. At the same time we feel very hopeful, and do not fear the scale any longer from the fact that we feel that we have got it under control. Beginning with the nurseries, and then gradually concentrating our work in the orchards in the infested districts. This we have been doing for the past three years, and are gradually encircling the pest, and ferreting out new localities when they are brought to our attention. By this warfare, we feel that we can keep this pest under control, and save our immense fruit interests." (Letter May 27th, 1899).

Prof. J. B. Smith, in Bulletin 140, New Jersey, October 31st, 1899, says:

"It may be said that while the scale has undoubtedly spread to a considerable extent, and has caused the death of some trees in New Jersey, yet there has been no abandonment of fruit growing, and no general killing out of orchards. Experience during the past year proves that we can control the insect at all times, and eradicate it locally under favorable circumstances. Experience has proved that it needs intelligent persistence to accomplish this."

Prof. L. H. Bailey says: "The San José Scale is still with us. It will stay. There is no hope of eradicating it. Then every man should be prepared to meet it. He should not rely on State control alone.

"For three seasons now, we have experimented with the kerosene and water emulsion—as others have done—and have found that it is a specific for the scale. In the proportion of 1 part of oil to 5 of water in summer, and 1 to 4 in winter, it will kill the scale.

"Can a man hope to annihilate the scale, then, by spraying? No. On plants which he can spray thoroughly and frequently, he can hope to eradicate it: but I should not expect him to eradicate it from a large and badly infested plantation, any more than he can eradicate the apple-scab or the bark-louse. But I should expect him to keep it in check. Spraying for San José scale must come to be an accepted practice, as spraying for potato blight is.

"All this means that the farmer should not be frightened, but should be self-reliant and determined. But the State should help him. The law should not help him less, but more. Nursery stock should be fumigated with hydrocyanic acid gas, under strict control. It would be folly to

attempt to burn every infested tree or bush wherever found; but the law should be so amended as to allow a properly qualified officer to destroy plants which, in the judgment of experts, are a menace to the general weal." (Cornell Bull. 177, Jan. 1900.)

Insect Enemies of Scale Insects.—In California the San José Scale is kept partly in check by lady-beetles, which feed upon it. There the mildness of the winters allows these beneficial beetles to multiply the year round, but in Ontario the long season prevents their rapid multiplication, for which reason we can never hop to receive sufficient aid from these allies to keep the scale anywhere in bound, although, undoubtedly, they do much to reduce the number of the scales.

Two forms of lady-beetles have been found on scale-infested trees in Ontario, and where these were numerous the scales were almost ex-

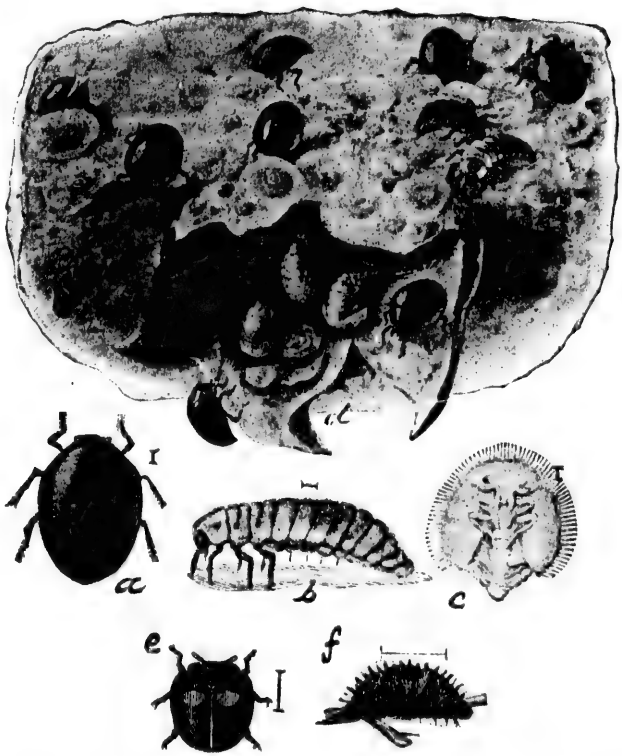


FIG. 10.—Two enemies of the San José Scale. (*a*) Beetle. (*b*) larva, (*c*) pupa of Pitiful Lady-beetle (Pentilia misella); (*d*) blossom end of pear, showing scales with larva and beetles feeding on them; (*e*) Twice-stabbed Lady-beetle (Chilocorus bivulnerus); (*f*) its larva. (*a*, *b*, *c* and *d*, after Howard & Marlatt, *e* and *f* after Riley.)

terminated. One form is the *twice-stabbed lady-beetle* (*Chilocorus bivulnerus*) (Fig. 10), in allusion to the two blood-red spots on the wing-

covers. It is a small beetle about one-fifth of an inch long, and about the same in breadth.

The larva of this beetle should be known to all fruit growers, for it is one of their best friends. It is a bristly creature, about one-third of an inch long. Where these larvæ are in sufficient numbers, their presence may be detected by the large number of their cast-skins or moults.

The other form is the *pitiful lady beetle* (*Pentilia misella*), a minute black creature, about the size of a scale itself, and devoid of any markings. The larva is without bristles, and is very active. Both the beetle and the larva feed upon the scale.

The Inspectors report several cases of complete extermination of the scale by one or both of the lady beetles. No person is in a position to state definitely how extremely valuable the small lady beetles are, but it is fair to assume that they prevent very frequently the spread of the scale by devouring the young scale lice which may happen to be brought to new trees.

Among other parasites of the San José scale in Ontario may be mentioned a minute, yellowish, four-winged fly, which I take to be *Aphelinus fuscipennis*. As many scales are met with which are punctured with a small hole made by this parasite, probably it does a valuable work in reducing the number of the pest.

During the past summer many mite-like creatures were observed in certain orchards in Kent county, but I have not been able to ascertain whether these mites feed on living or dead scales.

"In California, south of San Francisco, *Chilocorus bivulnerus* (twice-stabbed lady-beetle), and *Aphelinus fuscipennis* feed upon the scale for from six to eight weeks before the scale itself begins to reproduce, and in some places during its entire dormant period.

"During the period of greatest heat in California the scale is less active and reproduces slowly, while during that very time the parasite is most active, most abundant, and again has an advantage over the scale due to the climate. We cannot in New Jersey duplicate these natural conditions." (An. Rep. N. J. 1896, Prof. Smith.)

Dr. Howard, of Washington, says: "The possible usefulness of parasitic and predaceous insects, should, at least in the east, not be allowed for a moment to interfere with active operations with remedies, nor blind one to the importance of the San José scale, and the extraordinary precautions which should always be taken to prevent its wider dissemination."

Fungous Diseases.—On several occasions specimens have been found badly infested with fungous threads, but no means were at hand to tell whether these were the cause of the death of the scale, or whether the dead scale formed a suitable medium for the growth of the fungus. It is doubtful if the fungus which has been found preying upon the scale in Florida will be of much service in Ontario.

The Identification of the San José Scale.—With a little practice this scale can be readily identified with the aid of a good magnifying glass. The characters of the young scales are both *constant* and *peculiar*, as will be readily seen from a study of the table of comparisons on page 45.

The chief characters which should be noted are: (1) The color of the scale; (2) the color of the larvæ; (3) the color of the exuvia or nipple; (4) the shape of the male scales; (5) the position of the exuvia; (6) the absence of eggs; (7) the circular depressed ring about the nipples.

The only difficulty arises when isolated individuals are discovered on bark which obscures the usual color of the scales, but even then one can form a fairly correct guess. In such a case the use of a compound microscope will always solve the difficulty, for the form of the anal lobe is decidedly characteristic, as a study of Fig. 9 will show.

The majority of the inspectors engaged during the two past seasons in locating infested trees are, in my opinion, quite reliable. In doubtful cases they have almost invariably applied to the head inspector, who knows how to use the compound microscope, which he carries with him or to the entomologists at the Ontario Agriculture College, or the Dominion Experimental Farm. Dr. Howard, of Washington, in Bulletin 12, New Series, says: "As a matter of fact, with a little experience, *A. perniciosus* (San José scale) can be distinguished from either of the other species by the scale alone with a hand lens."

In justice to the Inspectors, I maintain we should not demand that they be intimately acquainted with all the scales, but that they be able to distinguish the San José scale from all other scales. The identification of the allied scales may be safely left to experts.

Occurrence on Forest Trees, etc.—The fact of the occurrence of the San José Scale on some forest trees and ornamental shrubs has been a strong argument with some against the possibility of exterminating the pest by the destruction of infested orchards. Undoubtedly this argument is of great weight; and in future operations, forest and other trees should be taken into account. In the Guilds District, Kent County, the scale has been found on elm, basswood, white ash, mountain ash, ornamental birch, four species of willow, and on many herbs, such as rhubarb, hemp, lamb's quarters, garden knotweed, hedge mustard, beggar-ticks (Bidens), maple leaf, goose-foot, ragweed, sunflower, and on such shrubs as black currant, white currant, rose, and spiræa. There is, however, no positive evidence that the scale developed to the extent of forming fully matured females or mothers on all of these plants.

The experience of the scale Inspectors in Ontario has been different from that of Prof. Webster, of Wooster, Ohio, who states that the elm becomes infested almost as often as it is exposed, and that he once saw an elm-tree as badly infested as any fruit tree he ever observed. The shade elms of St Catharines, although surrounded by badly infested trees, were declared free from scale by the inspectors after careful searches at different

times. Although the elms of Niagara township, where the scale is ver prevalent, have been frequently examined no scale been found on them and the only elm in Ontario known to the inspectors to be infested one near Guilds, on Mr. Bell's premises. It is true that it is difficult t examine all parts of a large tree, as many twigs and even branches wi be overlooked, yet if trees be susceptible to infestation from th scale, some traces of infestation would ere now have been discovered.

In view of Prof. Webster's experience, however, it would be advisabl to keep a careful watch on all forest trees exposed to infestation, even thoug our inspectors as yet have found them but slightly liable to infestation.

At Guilds the ornamental willows and birches have become infeste from surrounding trees, but the wild willows which grow in swamp lands are practically immune. In Niagara township the scale sprea rapidly in several orchards near Mr. Jas. Hutchison's, but a large are of second growth shrubs, composed of willow and poplar, which wa directly exposed to infestation, was declared free from scale after carefu search at different times by four or five inspectors.

To my mind the most dangerous sources of new infestations are ou common shrubs, such as currant, raspberry, gooseberry, rose, and spiræa which are readily affected. These are frequently overlooked in the searc for scale, and left growing in fence-rows as a standing menace to th more important interests of the orchard. Whenever infestation occur these shrubs should be ruthlessly destroyed—the axe-and-fire metho being the only proper one in dealing with plants like these.

Infested weeds should also be cut and burned, for although there i no danger that such plants will carry the scale over winter, as thei stems are annual and die down at the approach of cold weather, ye there is a danger that the young lice may be carried to shrubs and tree during the summer.

As regards any serious danger of orchard infestation from forest tree Prof W. G. Johnson, of Maryland, holds a decided opinion, as may be see from a letter he wrote me May 27th, 1899:

"I think it is nonsense for any person to take the stand that th scale will establish itself in orchards from the forests. I do not know o a single instance where this is the case in this or any other State. Th possibility of this insect working from forest trees and becoming estab lished in orchards is surely very meagre, as there are only a few tree found in our forests, especially in your own section, upon which th insect has been found at all, and in every instance these have been foun upon shrubs or very small trees. In my opinion there is no dange whatever of this pest becoming established on orchard trees if it i handled properly in the beginning."

2. The Ostreæform or Curtis Scale.

(Aspidiotus Ostreæformis.)

This scale was for many years supposed to be limited to a few areas in America—California and British Columbia; but recent studies and observations bring to light the fact that it is quite widely distributed.

Prof. C. L. Marlatt, in a recent article in *Science*, says:

"It seems to have become well established, notably in the vicinity of Geneva, N.Y."

It has been found at Wooster and Cleveland in Ohio, and also in our San José Scale infested areas at Kingsville, Guilds, St. Catharines, Niagara, and at Toronto.

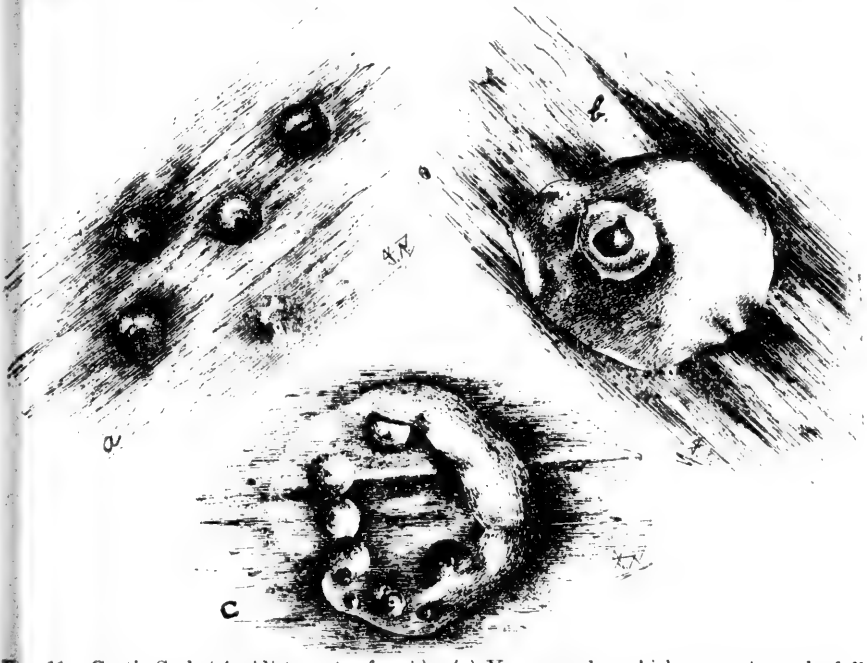


Fig. 11.—Curtis Scale (*Aspidiotus ostreæformis*). (*a*) Young scales which are not nearly full-grown; the nipple is plain, but the circular groove about it is wanting. (*b*) Full-grown pregnant female; the nipple is large. (*c*) Old scale with several young scales hidden beneath it—a characteristic feature. (Original.)

This pest is a native of Europe, and has been with us probably for eight or ten years or even longer, but on account of its great likeness to the Putnam Scale *(A. ancylus)*, its presence was not detected. My own observations lead me to the conclusion that this Curtis scale is capable of doing much damage, as many limbs have been found badly encrusted.

The scale has been found on apple, plum, pear, peach, maple, and willow trees.

Even under a hand lens this scale is somewhat difficult to distin-

guish from the Putnam. There is a tendency towards a grouping and a constant overlapping of the scales on twigs which are not badly infested.

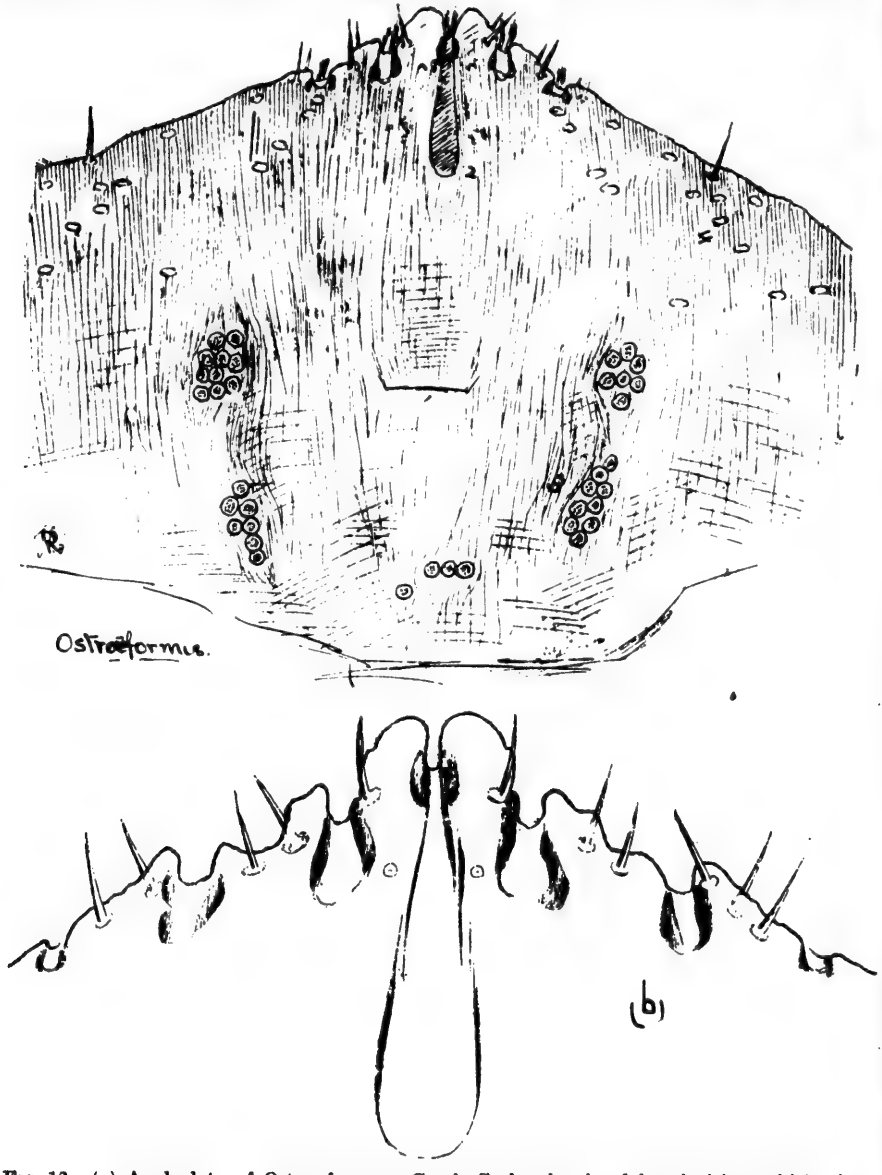


FIG. 12.—(*a*) Anal plate of Ostreæform or Curtis Scale, showing lobes, incisions, thickenings and spines. The inner angle of second lobe is decidedly developed; outer lateral margin of second lobe undulating; chitinous processes of first incision long and nearly equal in size. (*b*) Anal plate much enlarged. (Original.)

On many twigs, however, I have seen the young scales scattered somewhat evenly, but even on these the overlapping of the old scales was very apparent. The young forms are black, slightly resembling those of the San José Scale, but instead of a depressed, prominent ring about the nipple, there is a whitish ring. The adult female scales are circular, light grey in color, and the large orange-colored exuviæ are nearly central. The area immediately outside of the exuvia is sometimes dark in color, and the margin of the scale is very light grey. (Figs. 1 and 11.)

The male scales are flattened, and oval in shape, with the exuvia near the anterior enlarged end.

Reports from Michigan state that apple and soft maple trees have been killed outright by the attacks of this scale, and Prof. Marlatt, in his Presidential Address before the Association of American Economic Entomologists at Columbus in August, 1899, said:

"*Aspidiotus ostreæ formis*, recently introduced from Europe, is liable to be just as dangerous an insect as *perniciosus* (San José), and if it should be similarly widely distributed and equally actively exploited, would doubtless assume a similar importance, but with this advantage, that coming from Europe to us there could be legitimately no restriction on our commerce by European powers in consequence."

The orchardist should be on the outlook for this scale, for although not so destructive at present as the San José Scale, yet it must be borne in mind that it is perhaps the most destructive form known in Europe.

Microscopical Characters.—Median lobes of anal segment well developed; the inner margins of second lobes less than half the height of median lobes; outer lateral margins undulating; third lobes very small or rudimentary; chitinous thickenings between median lobes small, those in first incision nearly equal in size and quite large, while those in second incision are small; two small plates between median lobes, two branched plates in first incision, and a single plate (sometimes two) in second incision; a pair of spines on each of the lobes; ventral glands well forward, median none to six anterior laterals nine to eleven, posterior laterals eight to nine. (Fig. 12.)

3. The Cherry or Forbes Scale.

Aspidiotus Forbesi. (Figs. 1 and 13.)

The Cherry or Forbes Scale was discovered by Prof. W. G. Johnson on English morello cherry trees in Illinois in December, 1894. Prof. Johnson states that it is very generally distributed over Illinois, and is there considered a dangerous scale insect. He found the cherry scales on cherry, pear, plum, quince, apple trees, and currants. As a rule, however, this scale has done very little harm, and is but seldom found in large numbers. Outside of Illinois, in the United States, it has been reported from Kansas, Iowa, Michigan, New Mexico, Maryland and West Virginia.

The scale is not often seen in Ontario, but is abundant on one tree at

St. Catharines, on the premises of Mr. W. Tyson, Lake Street, and in an orchard in the township of Saltfleet, Wentworth County.

This scale insect passes the winter in a partially matured condition, but not so near maturity as is the case with the Putnam Scale. It is very probable that there are, at least, two broods in Ontario, although the full life-history has not been fully investigated, through the inspectors mistaking for a time the Curtis Scale for this one. The young larvæ appear before those of the San José, and the adult males appear much earlier—some time in May. The larvæ of the second brood appear about August 15th.

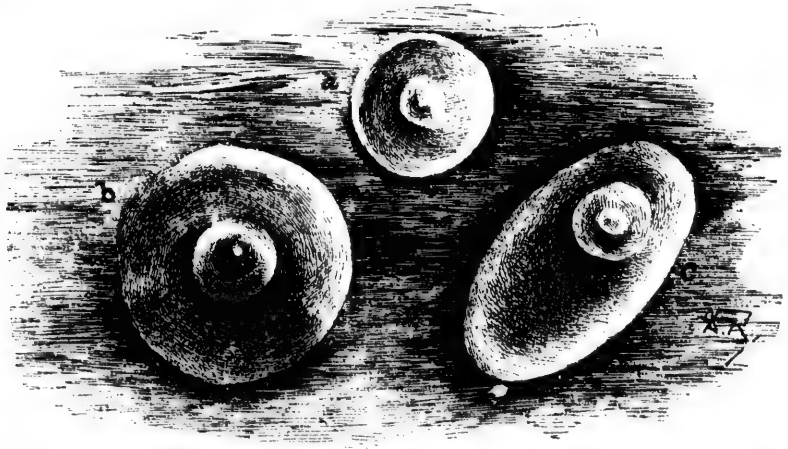


FIG. 13—Forbes or Cherry scale. (*a*) Young scale, light colored, with central nipple but no circular groove. (*b*) Adult female scale with central or nearly central, orange-colored nipple, and gray outer margin of scale. (*c*) Male scale, showing the oval shape, and nipple near one end. The body of the insect is under the scale. (Original.)

From the fact that a mature female with young and eggs was found as late as November 21st last year, it looks as if there were three broods in the Niagara region.

The female scales of this species resemble those of the Putnam Scale. The young larvæ are pale yellow; the old female scales are more convex and smaller than those of the Putnam; the exuvia is central or nearly so, and orange colored; the margins of the scales are decidedly lighter in color than the rest of the scale, and the male scale is oval in outline, with the exuvia near one end.

Microscopical Characters.—The median lobes of anal segment large, and *approximate* at apex; apex rounded; lobe notched on outer margin; the inner margin of second lobe well developed; outer margin generally notched; third lobe minute; the chitinous thickenings of the incision between median and second lobe *very unequal*, the inner being large and *club-shaped*, the outer thickening small; a pair of spines near outer base of each of the lobes; plates apparently wanting; ventral glands quite

characteristic, well forward; median, one to three; anterior laterals, three to seven; posterior laterals, three to five. (Fig. 14.)

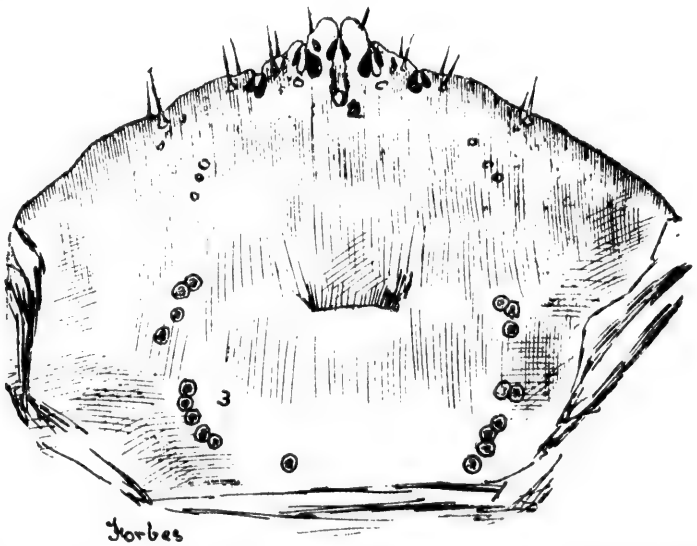


FIG. 14.—Anal plate of Forbes Scale, showing lobes, incisions, thickenings and spines; also anal opening (2), vaginal opening (1), and ventral glands (3). Notice that the median lobes approximate at apex, and that the inner thickening at first incision is very large and club-shaped. (Original.)

4. THE PUTNAM SCALE.

(*Aspidiotus ancylus.*)

This scale has been known for over twenty years in the eastern portion of the continent. It is a native of the country, and consequently is wide spread, occurring as it does all the way from Ontario to Iowa and Texas. The resemblance to the San José Scale is close, and it is often mistaken for the dreaded pest.

The exuvia is usually orange-red in color, when slightly rubbed, and eccentric. The color of the scale varies from a dark to a gray, depending upon the color of the bark.

The insect passes the winter in a partially matured condition. It is oviparous, while the San José Scale is viviparous.

Seldom has this scale been found in sufficient numbers to do much injury to fruit trees, but Prof. Webster reports that he has "found it clustered as thickly on currant bushes as the most destructive species possibly could, and destroying the bushes in precisely the same way."

The discoloration produced by this scale does not penetrate so deeply as that of the San José Scale; for, while the purplish color of the latter

extends into the bark, the Putnam discoloration seldom penetrates much deeper than the epidermis.

In Ontario the typical Putnam Scale has not often been found, but a variety prevails which has the second lobe of the anal plate slightly developed, and the incision between the first and second lobes not so wide as in the typical Putnam. Plum and black currant are its chief food plants with us, but it is commonly found on maple in Kansas; on birch, black maple, plum, and snowball at Ames, Iowa.

Prof. Cockerell, of New Mexico, gives the ash, maple, beech, linden, oak, osage, orange, peach, blackberry, bladdernut, and water locust as plants on which the scale has been found, and he thinks, as a general rule, it does not take kindly to fruit trees.

Microscopical Characters.—Median lobes prominent, notched on

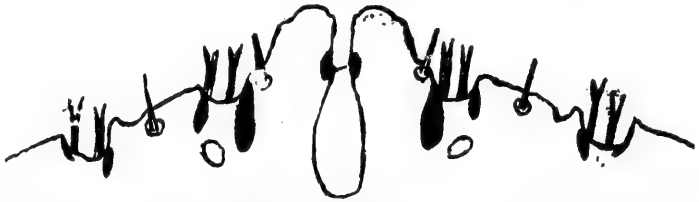


FIG. 15.—Anal plate of the Putnam Scale, showing the unequal thickenings in first incision, the rudimentary second lobe, and the wide interval between median and second lobes.

outer margin, and sometimes notched on the inner margin also, second lobe rudimentary as a rule, but with us slightly developed; third lobe also rudimentary; interval between the median lobe and the rudimentary second lobe is very wide; the chitinous thickenings between lobes are *far apart* and *unequal*; plates either simple or two-pointed or branched; ventral glands: anterior, none to five; anterior laterals, six to fourteen; posterior laterals, four to eight. (Fig. 15.)

5. THE ENGLISH WALNUT SCALE.

(*Aspidiotus juglans-regiæ.*)

This scale was found at St. Catharines, but, so far as I am aware, it is not destructive to our orchards. The insect has already been found in New York State, where it feeds on pear, cherry and locust.

Howard and Marlatt report its presence in Florida upon peach and wild plum; in New Mexico upon ash, apple, apricot and plum; in Texas upon peach; in Louisana upon peach; and in Japan, upon plum.

The exuvia of the scale is eccentric, and when rubbed is of a dark orange color. The scale is circular, and light gray to light brown in color. It occurs generally scattered on the trunk and twigs, but sometimes in little clusters. (Fig. 16.)

Microscopical Characters.—Median lobes low and broad, and but

slightly notched, if at all; second lobes with inner margin developed to half the height of medium lobe, notched on lateral margin; third lobe rudimentary or obsolete; chitinous thickenings at first incision unequal in size, inner one large; plates are simple; spines prominent; three or four rows of prominent dorsal glands; ventral glands; anterior, none to four, anterior lateral, six to sixteen, posterior laterals, six to eight. (Fig. 17.)

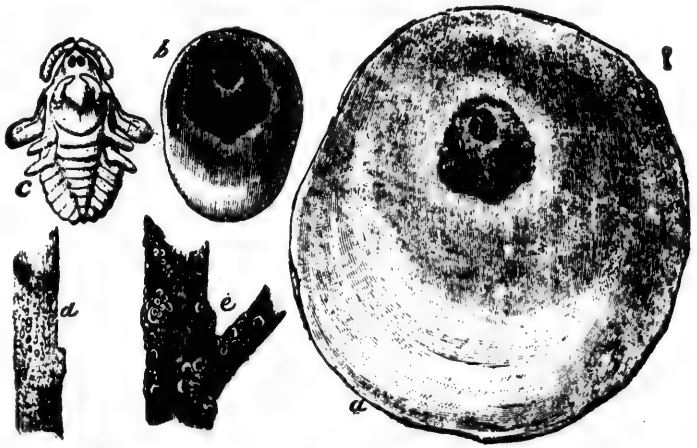


FIG. 16.—The English Walnut Scale (*Aspidiotus juglans-regiæ*). (*a*) Female scale; (*b*) male scale; (*c*) male chrysalis; (*d*) male scales on twig; (*e*) female scales on twig—*a*, *b*, *c* enlarged; *d*, *e* natural size. After Howard. From U.S. Dep. Agr., Year Book for 1894.

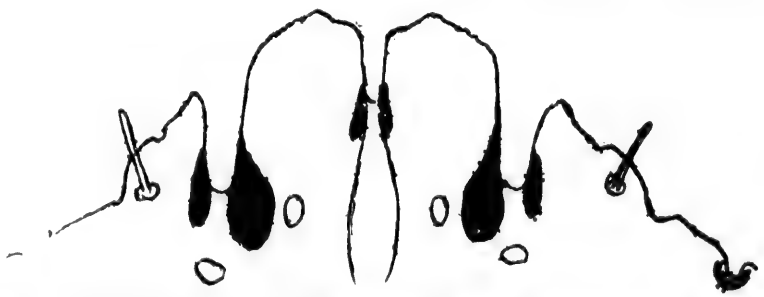


FIG. 17.—Anal plate of the English Walnut Scale, showing the large median lobes, and notched outer margin of second lobe.

6. The Oyster-Shell Bark-Louse.

(*Mytilaspis pomorum.*)

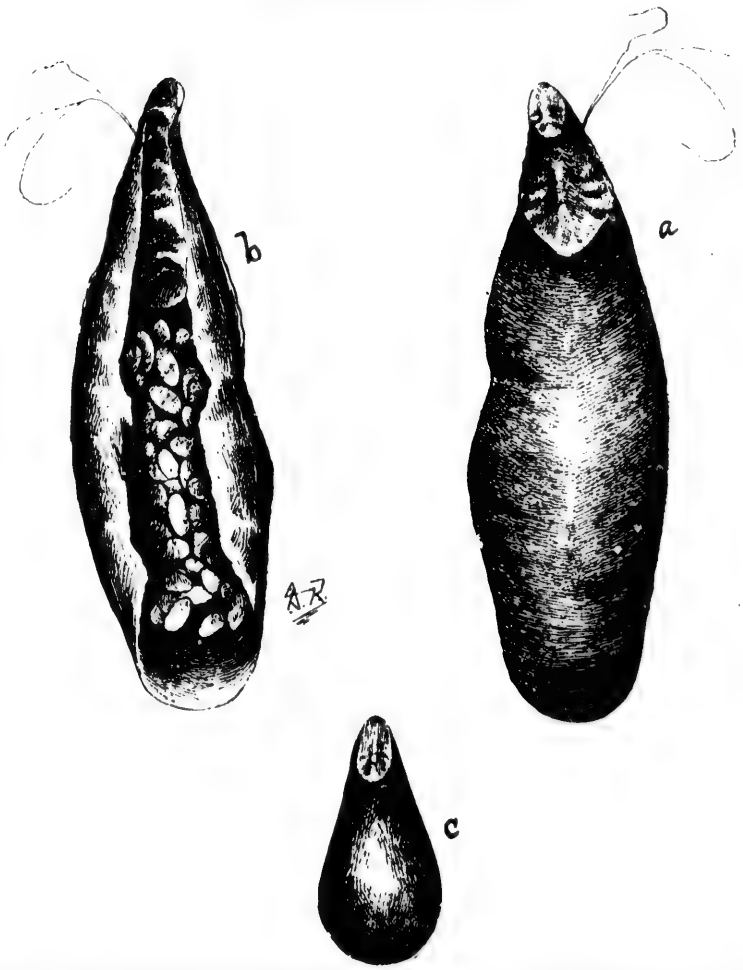


Fig. 18.—Oyster-shell Bark-louse (Mytilaspis pomorum). (*a*) Adult female, back view, showing the two moulted skins at anterior end, and the bristles of the sucking tube. (*b*) Adult female, turned over, showing the insect at the anterior end and the eggs at the posterior end. (*c*) Adult male scale, much smaller than female, with one moulted skin at anterior end. (Original.)

This scale is widely scattered throughout the orchards of Ontario, and does a considerable amount of damage.

Although of European origin it has been known in America for more than a century, and has gradually spread throughout the larger portion of North America.

This scale is a very serious pest in orchards which are neglected and badly treated, but experience has shown that with careful treatment it can be readily kept in check. This scale-insect has been found to occur on the following trees and shrubs: Apple, plum, pear, wild red cherry, grape, spiræa, juneberry, ash, birch, maple, poplar, willow, rose, and bittersweet.

In order to combat this scale it is very necessary that its life-history should be known.

This insect winters over in the egg condition. The eggs can be readily observed if, at any time from late fall to early spring, the old scales be lifted or turned over with the blade of a knife or a pin. They are dust-like to the naked eye, but under a magnifying glass their shape and color can be made out. They are oval, and whitish yellow.

The young, yellow lice escape from the eggs during the last week in May and the first two weeks in June, wander for a few hours, or a few days, on the limb, then settle down and secrete a scale. The larvæ moult, or shed their skins, twice in the course of their growth during the summer. These moults can be readily seen on the narrow end of the large scale. The adult female dies soon after the laying of the eggs (60) in the fall (October). Orchardmen should be familiar with the appearance of this scale, for it is easily recognized by its oyster-shell shape. The scale of the male insect is much smaller and less common than that of the female. Moreover, it has but one moult or cast skin at the narrow end of the scale. (Figs. 2 and 18.)

It is fortunate that this scale is single-brooded, for if it had as many broods as the San José Scale its power to do damage would be vastly greater than the latter, for eggs winter much better than immature larvæ.

Here is a letter from an orchardist, who did not know this scale, although many of his trees were nearly dead:

"I have a young orchard about eight years old of nearly three thousand apple trees. I noticed lately a tree about dead, leaves all off, and apparently killed by disease of some kind on the bark. I have no idea what this trouble is, whether an insect, or San Jose Scale, or what. Two or three trees near it have the same thing on, but not sufficiently so to kill the trees. I enclose a sample of one of the limbs, and would very much like to know what it is."

The sample sent was very badly encrusted. No doubt many other orchardists have the same difficulties in keeping their trees alive.

Remedies.—Winter applications, if properly made, are very efficacious. The best winter application is probably whale oil soap solution (2 lbs. to 1 gallon of water), thoroughly sprayed upon the branches and stem, or rubbed in with a brush. Perhaps the best time to treat oyster-shell bark-lice is after the hatching of the young lice from the eggs in June. The orchardist should spray thoroughly then with whale-oil (1 lb. to 2 gallons of water). Kerosene diluted with four or five times its volume of water has also been found very beneficial.

7. The Scurfy Bark-Louse.

(*Chionaspis furfurus*).

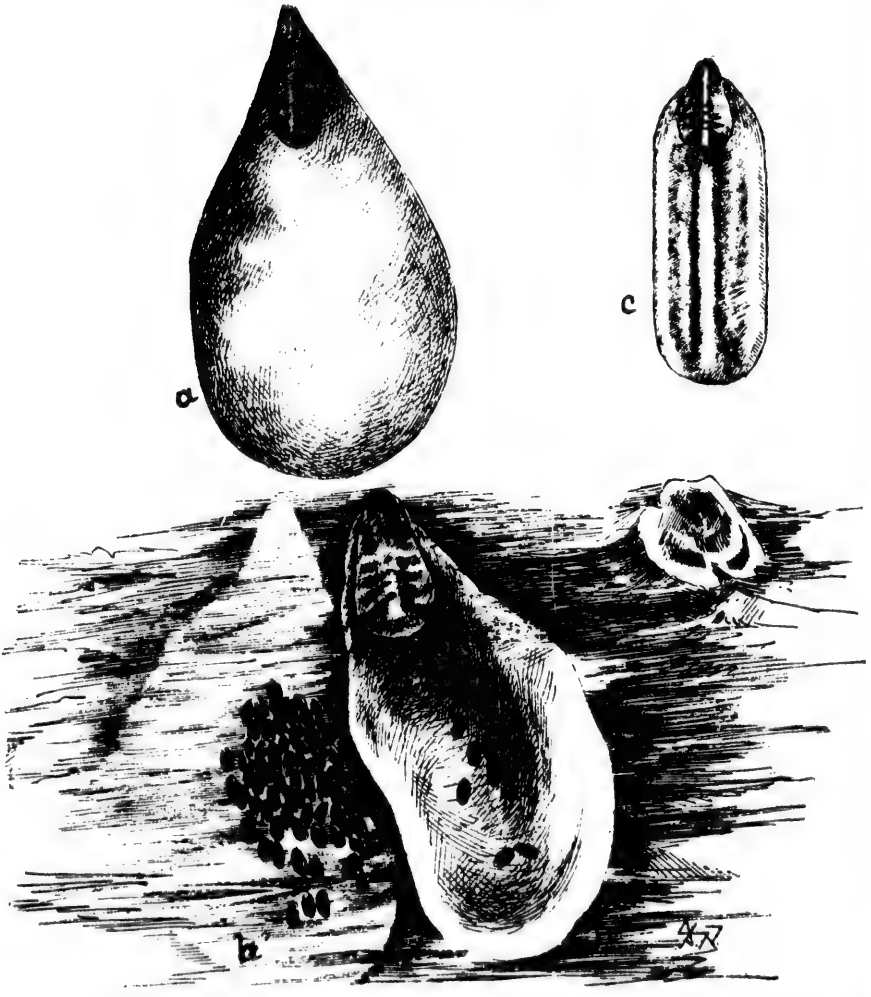


Fig. 19—Scurfy Bark-louse (Chionaspis furfurus). (*a*) Adult female scale, upper surface, showing the two moulted skins at anterior end, and enlarged posterior end of the white scale. (*b*) Adult female, under surface, showing the insect at anterior end, and the numerous purplish eggs. (*c*) Adult male, showing the one moulted skin, and the parallel sides and the three ribs. (Original.)

The Scurfy Bark-Louse is not so widely distributed through Ontario as th Oyster-Shell Bark-Louse, and has, in our experience, fewer host plants. It is very abundant on pear trees in many localities, and is also found quite commonly on apple, gooseberry, and black currant.

America is the native home of the Scurfy Bark-Louse, and in consequence is found in most of the eastern and middle states. This scale winters over in the egg state. The purplish colored eggs can be readily observed during the winter by lifting the scale with a pin or knife blade. The young lice appear about the middle of June when they can be seen on the infested branches. They crawl about for a few hours, then settle down and begin secreting a white scale. As there is but a single brood, its powers of reproduction are limited, and cannot be compared with the San José Scale in point of rapidity of infestation of an orchard.

The female scale is much larger and more oval than the male scale. It moults twice, and the moulted skins remain at the anterior end of the large scale. The male scale has its sides nearly parallel, and there is but one moult, which persists as a minute brass colored object at the anterior end of the adult scale. (Figs. 2 and 19).

The same remedies may be employed against the Scurfy Bark-Louse as are employed against the Oyster-Shell Bark-Louse.

8. The New York Plum Scale.

(Leconium prunastri).

In Wentworth and Lincoln Counties many valuable plum orchards are suffering very severely from the work of the New York Plum Scale, and several orchardists of these counties are afraid that their plum trees will be killed outright by the end of the coming season. For several years the orchards of Western New York have been seriously damaged by this plum scale, and in December, 1894, Prof. M. V. Slingerland, of Cornell University Agricultural Experiment Station, issued a valuable bulletin (83), dealing with the life-history, habits, and method of treatment. The accompanying figures will furnish a good idea of the form of this scale. (Figs. 2 and 20).

The large scales are very conspicuous, brown objects, and are the dead scales of the adult females of last season. The tiny egg-shells from which the young plum-scale lice escape may often be found under the old dead scales. On all the infested plum trees examined, I found the branches coated with a sooty, black fungus, which thrives well in the honey-dew secreted by the young scale.

In early April, the young scales which pass the winter on branches begin to move about in search of a suitable resting place, where they insert their beaks into the wood and obtain food. Before the end of June, these scales become full grown, and begin egg-laying. From the eggs the young larvæ, or lice, emerge in about a month, and crawl out on the leaves, where they remain till about the first of September, then they crawl back to the smaller branches, and are generally to be found in winter clustered in rows on the under surface

Remedy.—Prof. Slingerland, of Cornell University, who has had considerable experience in treating this scale, considers the kerosene emulsion treatment the best.

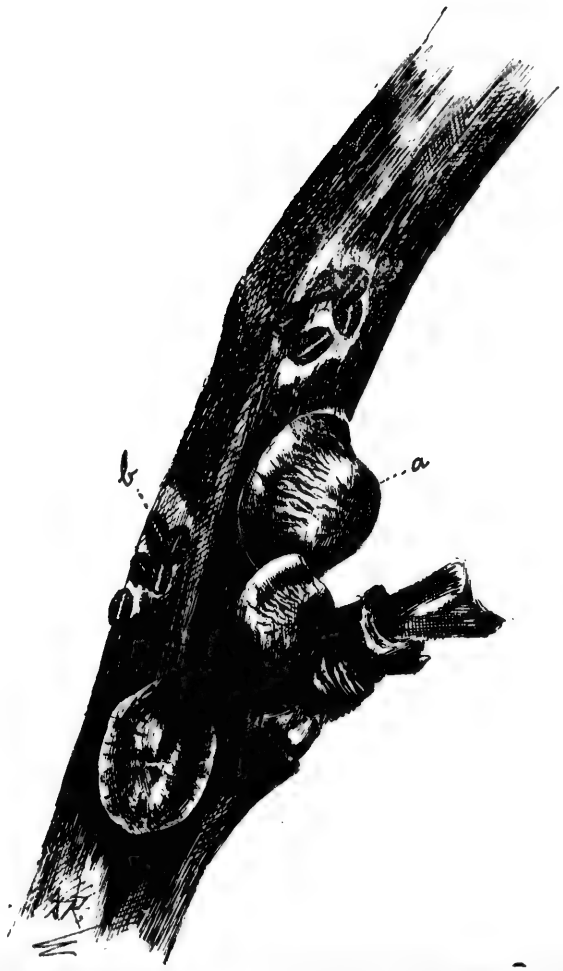


Fig. 20.—Twig of plum infested with Lecanium or New York Plum Scale. (*a*) The old scale of the previous summer empty and lifeless; (*b*) the immature wintering scales, which will become full grown like (*a*) next June. (Original.)

The standard kerosene emulsion is diluted with four parts of water, and applications are made by spraying twice or thrice between November and April when the leaves are absent from the limbs. Thoroughness is as essential in dealing with the New York Plum Scale as with the San José Scale, for every scale must be hit with the spray if it is to be killed.

A Comparison of Four Armored Scales.

San José (A. perniciosus).	Putnam (A. ancylus).	Cherry (A. Forbesi).	Curtis (A. ostreæ formis).
1. Viviparous, *i.e.* produces living young.	1. Oviparous, *i.e.*, lays eggs.	1. Oviparous.	1. Oviparous or ovo viviparous.
2. Winters partially matured.	2. Winters nearly matured.	2. Winters partially matured.	2. Winters half grown.
3. Male pupæ seldom found in early spring.		3. Male pupæ numerous in early spring.	
4. Winter scales circular, nearly black, with prominent deep circular groove about nipple; adult scales grey.	4. Scales usually grayish, or grayish-black, or like the color of the bark.	4. Border of scale lighter in color than the rest of the scale, which is generally grayish or like the bark; adult females more convex and smaller than those of Putnam.	4. Young scale—yellowish white to black; whitish ring about nipple.
5. Exuvia usually central, and in wintering forms nearly black with a whitish dot in centre; in adult forms lemon colored, when rubbed.	5. Exuvia seldom exactly central; color, light yellow.	5. Exuvia quite prominent, and usually orange colored; seldom exactly central.	5. Exuvia central; orange-colored; young scales are frequently found under the mother scale.
6. Two pairs of oval lobes in mature females; spinnerets wanting.	6. Two pairs of lobes, broad and flat; wide interval between the lobes; five groups of spinnerets in mature females.	6. Two pairs of oval lobes; median lobes approximate; inner thickening of first incision large and club-shaped; groups of spinnerets few in number; plates apparently absent.	6. Two pairs of oval lobes; thickenings of first incision long and nearly equal in size; five groups of spinnerets in mature females.

Note.—The characters sketched above are tentative, as every scale is liable to vary somewhat widely.

A Simple Key for Determining the Names of the Common Scale Insects.

By means of the following Key and a good magnifying glass any person may be able to analyze and find out the name of the scale under consideration :

A. Armored Scales. *Insects covered with a flattish scale.*
  B. Female scales round.
    C. Male scale round or but slightly elongated, similar in texture and color to that of the female.—*Aspidiotus.*
      D. Female scale with nipple central, with a distinct circular depression about the nipple, winter forms usually black, mature forms gray, exuvia light yellow, never orange.—*Aspidiotus perniciosus.*
      DD. Female scale grayish, nipple eccentric, exuvia orange, young scales frequently found under old scale, whitish ring about nipple.—*A. ostreæformis.*
      DDD. Female scale grayish, margin much lighter than remainder of scale, exuvia orange and large, seldom central.—*A forbesi.*
      DDDD. Female scale grayish, exuvia eccentric, yellow, winters nearly matured.—*A. ancylus.*
    CC. Male scales white and elongated.—*Diaspis.*
  BB. Female scales long.
    C. Female scale, oyster-shell shaped, narrow, brownish-black ; male scale smaller ; yellowish white eggs under female scale in winter.—*Mytilaspis pomorum.*
    CC. Female scale broad behind, white ; male scale smaller with parallel sides ; purplish eggs.—*Chionaspis furfurus.*
AA. Unarmored Scales.—Insects not covered with a *scale*—brown in color, hemispherical, winters as a larva.—*Lecanium prunastri.*

To illustrate the method of using this simple Key, let us suppose that specimens of scales have been collected, and that it is desired to ascertain their scientific and common names.

With a twig bearing the scale and a magnifying glass in the hand, we determine, first of all, whether the scale belongs to A., Armored Scales or AA., Unarmored Scales. Let us suppose in this case that we find the real insect under the scale-covering, then it belongs to A., Armored Scales. Then, next, is the female scale *round* or *elongated* ? A glance will show that it is (say) round, and accordingly belongs to B. and not to BB. Next, is the male scale *round* or *greatly elongated* and *white* ? Another look with the glass will settle that: It is slightly oval, but not white. Therefore it must belong to C. rather than CC. Finally, has the female scale a *central nipple* ? Perhaps the glass will not decide this point very positively, so we shall ask ourselves another question: Is there a *distinct circular depression about the nipple*? If yes, then the scale is *Aspidiotus perniciosus* (San José Scale). If no, then is the *exuvia orange*, and is there a *whitish ring about the nipple* ? Yes ; we decide in this case for the *Aspidiotus ostreæformis* (Curtis Scale.)

In like manner the names of any of the commonly occurring scales may be determined, if we can get specimens of both male and female scales. In the case of the scales which pass the winter in the egg stage, the shape of the female scales will at once tell us that they are either the oyster-shell bark-louse, or the scurfy bark-louse, which are easily distinguished.

How to Arrange a Cheap and Practicable Spray-pump for Spraying accurately dilute Kerosene and dilute Crude Petroleum.

While conducting the series of spraying experiments in orchards infested with the San José Scale in January and February of the present year, I experienced great difficulty at first in spraying *accurately* the 20 per cent. kerosene and the 25, 33 and 40 per cent. of crude petroleum. Many hundreds of tests were made at various times and places with each of the above percentages, but in no case did the pumps perform their work with any degree of accuracy. For example, when spraying with 20 per cent. kerosene it was found that the percentage of oil put on the tree varied from 15 to 30 per cent.; when spraying with the 25 per cent. crude petroleum, the percentage varied from 15 to 35 per cent., and so on with the 33 and the 40 per cent. crude petroleum.

A desirable pump for spraying oil and water.

Experiments revealed the fact that the oil and water tended to *separate readily in the hose.* When the tip of the rod was elevated a larger percentage of oil issued from the nozzle than was the case when the tip of the rod was horizontal or depressed.

After many attempts to arrange a suitable pump, Mr. G. E. Fisher, my assistant in the experiments, contrived a simple way of overcoming the difficulty. Two good spray pumps and their barrels were placed side by side, and their handles were fastened together by a bar so as to act as a single handle, working on an upright bar fastened to one of the barrels. One pumped water, the other kerosene or crude petroleum. By a simple adjustment the stroke of the two pumps was made to vary to any extent

so that any desired percentage of oil, or crude petroleum, could be obtained.

Each pump, moreover, had a hose of its own leading through a hollow rod to the nozzle, where the water and oil, or water and crude petroleum, were mixed and emulsified while being sprayed on the tree.

This simple method will enable fruit-growers to use the spray-pump which they have now. By coupling it with their neighbor's any desired percentage of kerosene or crude petroleum may be sprayed. The cost of the extra attachments ought to be trifling.

The writer is deeply indebted to the following persons for kind assistance in the preparation of this Bulletin: Dr. L. O. Howard, and Professor C. L. Marlatt of Washington, Dr. Fletcher of Ottawa, Prof. W. G. Johnson of Maryland, Prof. F. M. Webster of Ohio, Dr. J. B. Smith of New Jersey, and Mr. G. E. Fisher, Inspector of San José Scale in Ontario. To all of these gentlemen the writer tenders his hearty thanks for services rendered.